DOCUMENT RESUME

ED 273 832	CE 045 073

AUTHOR	Welch, A. W.
TITLE	The Nursery Worker. Teacher Guide. Revised.
INSTITUTION	Ohio State Dept. of Education, Columbus. Agricultural Education Service.; Ohio State Univ., Columbus. Agricultural Curriculum Materials Service.
REPORT NO	AGDEX-954
PUB DATE	84
NOTE	457p.
AVAILABLE FROM	Ohio Agricultural Education Curriculum Materials Service, 2120 Fyffe Road, Room 254, Columbus, OH 43210-1099 ($34.00).
PUB TYPE	Guides - Classroom Use - Guides (For Teachers) (052)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	Accounting; *Agricultural Education; Behavioral Objectives; Botany; Glossaries; *Horticulture; Learning Activities; Marketing; *Nurseries (Horticulture); *Nursery Workers (Horticulture); *Ornamental Horticulture Occupations; Pesticides; Pests; Plant Growth; Plant Propagation; Puzzles; Recordkeeping; Secondary Education; Soil Science; Vocabulary Development; *Vocational Education

ABSTRACT

This teacher's guide is designed for use in a vocational horticulture course designed to prepare students for jobs as nursery workers. Addressed in the individual units of the guide are the following topics: the nursery industry; soils; plant growth; plant nutrition; plant propagation methods; nursery field practices; pest control; techniques for storing, grading, and marketing nursery stock; and procedures for keeping records and accounts. Each unit contains some or all of the following: performance checklists, suggested learning activities, a study guide in the form of key questions, a list of technical vocabulary, crossword puzzles, word mazes, quizzes or tests, answers to the quizzes or tests; and transparency masters. A glossary concludes the guide. (MN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED273832

BEST COPY AVAILABLE

AGDEX 954

THE NURSERY WORKER

Teacher Guide

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

☒ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

● Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY
OA ECMS
R Roediger
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE045 073

OHIO AGRICULTURAL EDUCATION CURRICULUM MATERIALS SERVICE

Agricultural Education Service
State Department of Education

and

Department of Agricultural Education
The Ohio State University

AGDEX 954

THE NURSERY WORKER

Teacher Guide

Revised by

A.W. Welch, 1984

Special Project Consultant
Elton M. Smith

Copyright ©, 1984

Ohio Agricultural Education Curriculum Materials Service
The Ohio State University

All rights reserved

Ohio Agricultural Education Curriculum Materials Service
The Ohio State University
Room 254, 2120 Fyffe Road
Columbus, Ohio 43210

1984

James E. Cummins, Director
Agricultural Education Service
State Department of Education

Roger D. Roediger, Director
Ohio Agricultural Education
Curriculum Materials Service

The Ohio Agricultural Education Curriculum Materials Service, as a part of The Ohio State University, is an equal opportunity employer and does not discriminate against any individual for reasons of race, color, creed, religion, national origin, or sex. All instructional materials provided by the Ohio Agricultural Education Curriculum Materials Service are available on a non-discriminatory basis without regard to race, color, creed, religion, national origin, or sex.

INTRODUCTION

Nursery work or nursery production is a common unit taught in vocational horticulture classes. *The Nursery Worker* is designed as a reference for students preparing for employment in nursery work. Each chapter is written to help students gain competence in a specific area. Included are: an introduction to the nursery industry; soils; plant growth; plant nutrition; plant propagation methods; nursery field practices; controlling pests; storing, grading, and marketing nursery stock; and keeping records and accounts. You should supplement these units by assembling further references for students and by providing appropriate field trips in the community. Classroom teaching should be followed by home improvement projects or school projects in which students have a chance to develop additional skills and understanding under teacher guidance.

The materials in *The Nursery Worker Teacher Guide* coincide with the student manual, *The Nursery Worker*. This guide includes: 1) performance checklists, 2) suggested learning activities, 3) a study guide or "key questions" for each chapter, 4) a technical vocabulary or "terms to remember" for each chapter, 5) crossword puzzles enabling students to practice using the technical terms, 6) word mazes to familiarize students with specialized terminology, 7) quizzes and/or tests, 8) answers to quizzes and exercises, 9) transparency masters, and 10) a glossary of technical terminology used in the nursery trade.

These items are provided to save you time in preparing for and teaching the instructional units. Overall, the author hopes they will help you and your students make better use of *The Nursery Worker*.

Laboratory Activities and Experiments

The laboratory activities and experiments suggested are just a few of many which can facilitate student acquisition of knowledge and skills. Task sheets are available to supplement many chapters in *The Nursery Worker*.

Vocabulary

A section of floriculture vocabulary has been included. The exercises in this section are designed to help students in two ways, regardless of their background or ability. First, the exercises will familiarize them with basic vocabulary used in nursery production. Second, the exercises will provide students with vocabulary skills needed for successful employment in floriculture.

Vocabulary exercises include: 1) Terms to Remember which provide students with definitions of terms within the context of *The Nursery Worker*, and 2) Crossword Puzzles based on word definitions. In some instances, several versions of the same puzzle have been included to facilitate make-up work or needed repetition. You may find the vocabulary exercises most useful for students in introductory courses who are not yet familiar with the technical terms and vocabulary associated with horticulture. If you wish to test your students' mastery of technical terms, try administering the vocabulary exercises as quizzes.

Assigning students to work in small groups may facilitate completion of vocabulary exercises, Students often learn more working together than individually. One good motivator is a contest among small groups to be first in either timing or accuracy in a givcen exercise. In all cases, students should be encouraged to refer to their own copies of *The Nursery Worker*.

A note on use of vocabulary exercises - Terms to Remember should be assigned *with* the reading assignment or immediately preceding it. Crossword Puzzles are designed to reinforce student knowledge of terms and concepts. They can be used as a study tool prior to unit tests, thus encouraging students to refer back to the text. When used in "supervised study," the only reference needed for completion of most crossword puzzles is *The Nursery Worker*, although dictionaries may be provided if desired.

Key Questions

The Key Questions provide a review of the important points of each chapter. They contain many thought-provoking questions and encourage students to refer to *The Nursery Worker Student Manual*, page numbers for which are included in parentheses. These study guides can be valuable when assigned with the reading material. In some cases they are suitable for use as unit tests or make-up tests.

Sample Test Items

The suggested test items included should be modified to suit your needs and the needs of your students. These test items are included mainly to reduce the time you must spend in preparing written evaluation in the area of nursery production. The sample test questions can serve as models for development of additional test items. The questions may also serve as a means of defining critical information the students need to know. Test items may be used as either pretest or posttest exercises.

Transparency Masters

Transparency masters have also been provided to facilitate classroom discussion of topics in *The Nursery Worker.* A brief narrative and sample questions (where applicable) are included for each master in this guide.

Glossary

The glossary provides definitions of technical terms found in *The Nursery Worker*. Copies of this glossary may be useful for students to use when completing the vocabulary exercises.

ACKNOWLEDGMENTS

The Nursery Worker Teacher Guide is the result of contributions by the following people:

Karen Eggimen, Vocational Horticulture Instructor, Licking County Joint Vocational School, Newark, Ohio

Diane Feichtmeier, Vocational Horticulture Instructor, Warren Western Reserve High School, Warren, Ohio

Erik Munson, Vocational Horticulture Instructor, Montgomery County Joint Vocational School, Clayton, Ohio

Mark Mechling, Vocational Horticulture Instructor, Muskingum Area Joint Vocational School, Zanesville, Ohio

L. H. Newcomb, Professor of Agricultural Education, The Ohio State University, Columbus, Ohio

Robert Niemeyer, Vocational Horticulture Instructor, Apollo Joint Vocational School, Lima, Ohio

Ron Powell, Graduate Teaching Assistant, Agricultural Education Department, The Ohio State University, Columbus, Ohio

James P. Scott, Jr., Vocational Horticulture Instructor, Buckeye Joint Vocational School, New Philadelphia, Ohio

Gary Theil, Vocational Horticulture Instructor, Northeast Career Center, Columbus, Ohio

Antoinette W. Welch, Vocational Education Consultant, Ohio Agricultural Education Curriculum Materials Service, The Ohio State University, Columbus, Ohio

The Curriculum Materials Service staff members - Muriel King, editing and layout; and Jacqueline Rehm, phototypesetting.

CONTENTS

Introduction iii

Acknowledgments iv

Chapter 1. Introduction to the Nursery Industry 1-1

- Performance Check List 1-1
- Suggested Learning Activities 1-1
- Sample Interest Approach 1-2
- Key Questions 1-3
- Terms to Remember 1-5
- Crossword Puzzle 1-6
- Student Exercises 1-7
- Quiz 1-12
- Answer Key 1-13
- Glossary 1-14
- Narratives for Transparency Masters 1-15
- Transparency Masters 1-16

Chapter 2. Soils 2-1

- Performance Check List 2-1
- Suggested Learning Activities 2-2
- Sample Interest Approach 2-2
- Key Questions 2-3
- Terms to Remember 2-12
- Crossword Puzzles 2-16
- Letter Mazes 2-20
- Student Exercises 2-22
- Quiz 2-38
- Answer Key 2-41
- Glossary 2-45
- Narratives for Transparency Masters 2-47
- Transparency Masters 2-50

Chapter 3. Plant Growth 3-1

- Performance Check List 3-1
- Suggested Learning Activities 3-2
- Sample Interest Approach 3-2
- Key Questions 3-3
- Terms to Remember 3-8
- Crossword Puzzle 3-12
- Letter Maze 3-14
- Student Exercises 3-15
- Quiz 3-23
- Answer Key 3-26
- Glossary 3-30
- Narratives for Transparency Masters 3-32
- Transparency Masters 3-36

Chapter 4. Plant Nutrition 4-1

- Performance Check List 4-1
- Suggested Learning Activities 4-2
- Sample Interest Approach 4-3
- Key Questions 4-4
- Terms to Remember 4-8
- Crossword Puzzle 4-9
- Letter Maze 4-10
- Student Exercises 4-11
- Quiz 4-20
- Answer Key 4-22
- Glossary 4-24
- Narratives for Transparency Masters 4-25
- Transparency Masters 4-27

Chapter 5. Plant Propagation Methods 5-1

- Performance Check List 5-1
- Suggested Learning Activities 5-2
- Sample Interest Approach 5-3
- Key Questions 5-4
- Terms to Remember 5-8
- Crossword Puzzle 5-10
- Letter Mazes 5-12
- Student Exercises 5-14
- Quiz 5-27
- Answer Key 5-30
- Glossary 5-33
- Narratives for Transparency Masters 5-35
- Transparency Masters 5-39

Chapter 6. Nursery Field Practices 6-1

- Performance Check List 6-1
- Suggested Learning Activities 6-2
- Sample Interest Approach 6-2
- Key Questions 6-3
- Terms to Remember 6-7
- Letter Maze 6-9
- Crossword Puzzle 6-10
- Student Exercises 6-12
- Quiz 6-33
- Answer Key 6-36
- Glossary 6-39
- Narratives for Transparency Masters 6-40
- Transparency Masters 6-43

Chapter 7. Controlling Pests 7-1

- Performance Check List 7-1
- Suggested Learning Activities 7-2
- Sample Interest Approach 7-2
- Key Questions 7-3
- Terms to Remember 7-10
- Letter Maze 7-13
- Crossword Puzzle 7-14
- Student Exercises 7-16
- Quiz 7-29
- Answer Key 7-33
- Glossary 7-37
- Narratives for Transparency Masters 7-39
- Transparency Masters 7-43

Chapter 8. Storing, Grading, and Marketing Nursery Stock 8-1

- Performance Check List 8-1
- Suggested Learning Activities 8-1
- Sample Interest Approach 8-2
- Key Questions 8-3
- Terms to Remember 8-5
- Crossword Puzzle 8-6
- Letter Maze 8-7
- Student Exercises 8-8
- Quiz 8-10
- Answer Key 8-12
- Glossary 8-13
- Narratives for Transparency Masters ... 8-14
- Transparency Masters 8-15

Chapter 9. Keeping Records and Accounts . 9-1

- Performance Check List 9-1
- Suggested Learning Activities 9-1
- Sample Interest Approach 9-1
- Key Questions 9-2
- Terms to Remember 9-4
- Crossword Puzzle 9-5
- Letter Maze 9-6
- Student Exercises 9-7
- Quiz 9-11
- Answer Key 9-12
- Glossary 9-13
- Narratives for Transparency Masters ... 9-14
- Transparency Masters 9-16

GLOSSARY G-1

CHAPTER 1

INTRODUCTION TO THE NURSERY INDUSTRY

PERFORMANCE CHECK LIST

1. Describe the scope of the nursery industry.
2. List four types of services performed by nursery employees.
3. List six skills necessary for job entry.
4. List five traits of nursery employees needed for advancement in a nursery business.
5. Identify six titles of various nursery workers found in a large nursery operation.
6. Describe at least four new developments in the nursery industry.

SUGGESTED LEARNING ACTIVITIES

1. Take field trips to observe the different types of nurseries in your area. Take notes or photographs during these trips. Interview nursery operators and employees to identify types of jobs available and qualifications needed.
2. Have each student visit a local horticultural firm and complete the "Job Survey Form" from the *General Record Book*.
3. Have each student spend one day in a local nursery firm "shadowing" a nursery employee.
4. Invite local nursery operators to visit your school and speak to the horticulture class about their businesses and job opportunities in nursery work.
5. Have former students who are now working in the nursery industry speak to the horticulture class.
6. Have representatives from colleges and technical schools speak to the horticulture class or provide information on additional training and careers in the nursery industry.
7. Make a list of advanced training programs available in nursery work, including the requirements for entering these programs. Guidance counselors may be helpful here.
8. Create a display or bulletin board illustrating the types of careers available in the nursery industry.
9. Have each student develop a resume.
10. Obtain copies of current horticultural periodicals and catalogs for the classroom library. Suggested periodicals and their sources include:

    American Nurseryman, 310 South Michigan Avenue, Suite 302, Chicago, IL 60604

    The Buckeye Nurseryman, 2021 East Dublin-Granville Road, Suite 185, Columbus, OH 43229

    Florida Nurseryman, P.O. Box 16796, Temple Terrace, FL 33687

    Pacific Coast Nurseryman, 832 South Baldwin Avenue, Arcadia, CA 91006

    Southern Florist and Nurseryman, 120 St. Louis Avenue, Fort Worth, TX 76101

SAMPLE INTEREST APPROACH

Take a walk outside and look at several attractive landscape plantings. Ask students where these plants come from. If they say garden centers or other retail outlets, ask where these firms obtain the plants. Slides of landscapings can be substituted for the walk outside.

Make sure students understand the concept of a plant nursery. A plant nursery cares for young plants just as a children's nursery cares for babies.

What kinds of jobs must be done in a plant nursery to care for the young plants?

What do human babies and "baby" trees have in common? Both need food and water and special care to grow and mature. Do "baby" trees need changing as human babies do? No, but some may need to be "trained." To explain this, show photos of espaliers or grafted plants that have been staked.

NAME ____________________

KEY QUESTIONS FOR CHAPTER 1

The Nursery Industry

1. What are the major types of businesses in the commercial nursery industry? (pages 1-2)*

2. How do mail-order nursery businesses differ from most other businesses? (page 2)

3. What is the difference between field stock and container stock? (glossary)

4. List five of the major types of crops produced by commercial nurseries. (page 3)

Jobs in the Nursery Industry

5. List three entry level jobs in the nursery industry. (page 6)

6. List five characteristics supervisors look for when hiring nursery employees. (page 6)

New Challenges in the Nursery Industry

7. How is the increased use of machinery and automation changing the nursery industry? (page 8)

(continued)

---

*Page numbers given throughout are from *The Nursery Worker Student Manual.*

Key Questions *(continued)*

8. What are plant patents and how do they help the nursery industry? (page 8)

9. How have advances in the chemical industry influenced work in the nursery industry? (page 8)

10. How has the use of tissue culture affected the nursery industry? (page 10)

NAME ____________________

TERMS TO REMEMBER

Chapter 1

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word.

Technical Vocabulary

broadleaf evergreen
conifer
container stock
field stock
garden center
hourly worker
landscape maintenance
landscaping
narrowleaf evergreen
nursery
piece-rate worker
retail
salaried worker
wholesale

____________________ 1. Workers paid a flat rate regardless of the number of hours they work or the amount of work they do.

____________________ 2. Plants grown in some type of container.

____________________ 3. A business which grows woody and/or herbaceous plants.

____________________ 4. Plants with relatively broad leaves (as opposed to needles) that remain green all year.

____________________ 5. Selling merchandise to other businesses rather than to consumers.

____________________ 6. Improving the environment with the design and construction of plantings.

____________________ 7. Plants with needlelike leaves that remain green all year.

____________________ 8. Plants grown in the field as opposed to containers.

____________________ 9. Cone-bearing plant with needlelike leaves.

____________________ 10. A retail business generally selling plants and related supplies.

____________________ 11. Workers who are paid by the hour.

____________________ 12. Selling merchandise to consumers as opposed to other businesses.

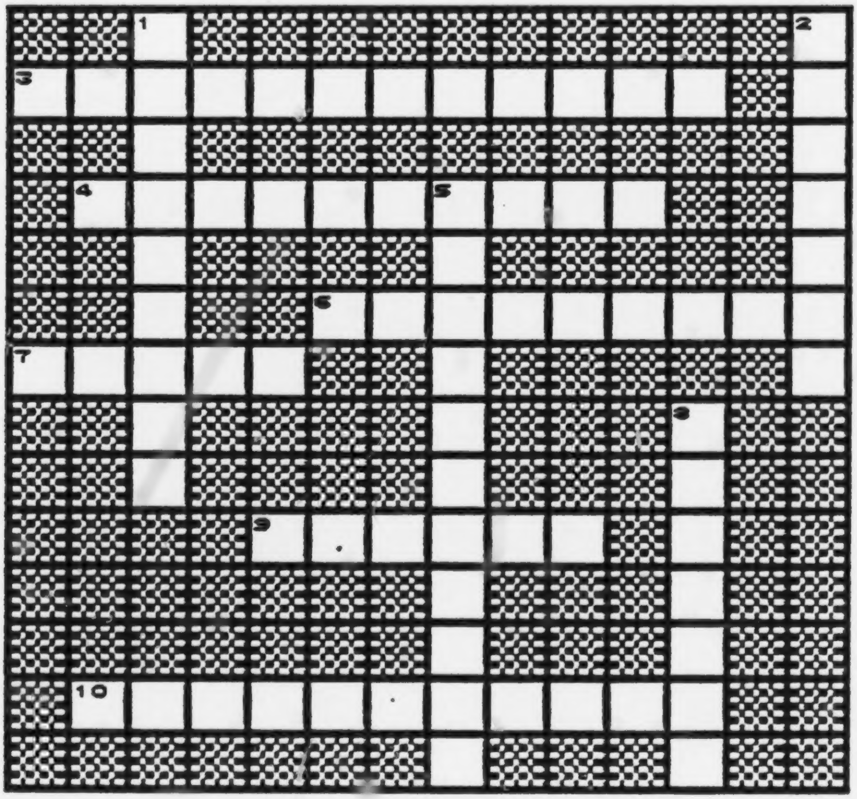
____________________ 13. Workers (usually temporary) paid by the amount of work they do rather than by the hour.

____________________ 14. Caring for established plantings.

NAME ______________________

CROSSWORD PUZZLE 1

Fill in the crossword puzzle with the missing words.



ACROSS Clues

3. A retail business generally selling plants and related supplies. (2 words)
4. Plants with needlelike leaves that remain green all year — ________ evergreens.
6. Nursery crops grown in pots, cans, tins, etc. — ________ stock.
7. Nursery plants growing directly in the ground — ________ stock.
9. A ________ nursery sells plants directly to consumers.
10. Landscape ________ firms care for established landscapes.

DOWN Clues

1. Plants with relatively wide leaves that remain green all year — ________ evergreens.
2. A business which grows woody and/or herbaceous plants.
5. Improving the environment with the design and construction of plantings.
8. A cone-bearing plant with needlelike leaves.

NAME ______________________

STUDENT EXERCISE 1-A

UNDERSTANDING THE NURSERY INDUSTRY

The nursery industry is a rapidly growing and changing field. Nursery production includes a variety of business firms from small one-person operations to large chain stores. All of these firms, regardless of size, have one thing in common — their interaction with and dependence on the overall nursery industry network and how local firms are linked to it.

MATERIALS:

- local telephone books
- road maps of the local area
- felt tip marker
- paper and pencil

PROCEDURE:

1. Using telephone books, identify all the local firms which are part of the nursery industry. Include nursery operations, garden centers, etc.
2. Record the name and address and write a brief description of each firm on a separate sheet of paper.
3. On a local road map locate all the nursery firms you listed. Then, with a felt tip marker, place an "X" at the location of each.

QUESTIONS:

1. How many nursery operations are in your area? ______________

   How many garden centers? ______________

2. Based on your answers to question 1, what types of nursery-related jobs are most readily available in your area?

   ____

   ____

EVALUATION:

1. Information regarding local nursery firms was accurately compiled and neatly listed. ______________
2. All nursery firms were located correctly on the map. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 1-B

NURSERY CROPS

The objective of this exercise is to familiarize you with the local nursery industry. You will learn some basic principles of nursery marketing by determining whether a crop is produced locally or is shipped in from other locations.

MATERIALS:

- list of nursery firms compiled in Exercise 1-A
- wholesale and/or retail nursery catalogs
- current trade publications
- paper and pencil
- prior arrangements made with local nursery firms to visit operation or to obtain information by telephone

PROCEDURE:

1. Using nursery catalogs or lists of plant materials available throughout the year, compile a list of nursery stock which is produced locally.
2. Using the same references, make a list of nursery stock which is **not** produced locally. Indicate on this list where the plant materials are produced.

EVALUATION:

1. List of locally produced plant materials was accurately and neatly compiled. ____________
2. List of plant materials produced in other areas was accurately and neatly compiled. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 1-C

MARKETING NURSERY CROPS

The objective of this exercise is to familiarize you with marketing alternatives available to local nursery producers.

RESOURCE:

- prior arrangements made with selected local nursery firms to visit operation or to obtain information by telephone

PROCEDURE:

1. Through group discussion and use of references, develop a list of possibilities for marketing nursery crops; that is, determine where crops can be sold.
2. Visit or call selected nursery firms. Ask the nursery operator to review your list and determine its accuracy. The nursery operator should also be asked to provide details on pricing, commission, and other factors relating to common marketing practices.
3. Discuss your findings in class.

EVALUATION:

1. All information was neatly and accurately recorded. ____________
2. Meaningful contact was made with local nursery firms. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 1-D

NURSERY JOB CLASSIFICATIONS

The objective of this exercise is to help you identify the job classifications used in local nurseries. When you have completed this activity, you should be able to write simple job descriptions for most common nursery positions.

MATERIALS:

- paper and pencil
- resource people who are familiar with the local nursery industry. (In addition to your teacher, these may include local nursery operators, Cooperative Extension agents, nursery association representatives, advisory committee members, etc.)

PROCEDURE:

1. After talking with your resource people, make a list of the various job classifications used in local nurseries.
2. For each title write a simple job description. Include requirements for job entry and a list of tasks performed while working.

EVALUATION:

1. Job classifications were accurately compiled and neatly listed. ______________
2. Appropriate descriptions were completed for each classification. ______________
3. All work was completed neatly and on time.____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 1-E

REQUIRED JOB SKILLS

The objective of this exercise is to make you aware of how your personal characteristics, skills, and knowledge compare with those required for successful employment in the nursery industry.

MATERIALS:

- paper and pencil
- job classifications from Exercise 1-D
- job descriptions from local nursery firms
- "Vocational Horticulture Occupational Tasks and Proficiency Record" from your *Horticulture Record Book*

PROCEDURE:

1. Select from your list of job descriptions an entry level position for which you might apply.
2. From the list of skills in your *Record Book*, select those skills which are important for the job you selected.
3. Prepare a written resume which will support your application for the job selected. List on the resume those important skills which you can perform successfully (see Figure 1-1).

Figure 1-1. Items to Include in a Resume

- name
- address
- phone number
- work experience
- special skills
- school activities
- community activities
- 2 or 3 references

QUESTIONS:

1. Are there any important skills which you have not yet mastered?
2. If so, list those skills on a separate sheet of paper and explain how you could become proficient in those areas.

EVALUATION:

1. Skills necessary for employment in the selected position were accurately compiled and neatly listed.

____

2. A resume supporting your application for the selected job was accurately and neatly compiled.

____

FINAL GRADE ________

NAME ____________________

QUIZ - CHAPTER 1

TRUE OR FALSE

Read each statement completely. If the statement is true, circle "T." If the statement is false, circle "F."

T F 1. Wholesale nurseries sell plant material directly to consumers.

T F 2. Retail nurseries sell plant material directly to consumers.

T F 3. Mail-order nurseries typically develop a catalog.

T F 4. Entry-level workers in the nursery industry generally begin at minimum wage.

T F 5. Many entry-level jobs in the nursery industry require manual labor.

T F 6. New specialized equipment has enabled many nursery operators to cut production costs.

T F 7. Plant patents protect people who originate new forms of plants.

MULTIPLE CHOICE

Read each item and decide which choice answers the question or completes the statement. Circle the letter of the correct answer.

8. Which of the following is classified as a major crop for the nursery industry as a whole?

   A. perennials C. broadleaf evergreens
   B. roses D. ground covers

9. Which of the following states is a leader in the production of nursery stock?

   A. Georgia C. Kansas
   B. Arizona D. Ohio

10. Wholesale nurseries may sell plants to all of the following **except:**

    A. other nurseries C. garden centers
    B. homeowners D. landscapers

11. The region of Ohio that has the bulk of the nursery industry is:

    A. Southeast C. Northeast
    B. Southwest D. Northwest

12. Students who graduate from vocational horticulture programs should expect to begin employment at the following level of the organization:

    A. crew member C. supervisor
    B. assistant superintendent D. assistant supervisor

13. Which of the following nursery crops is of greatest importance in the United States?

    A. annuals and bedding plants C. roses
    B. conifers D. foliage and house plants

ANSWER KEY - CHAPTER 1

Key Questions - page 1-3

1. nursery stock producers
   landscape firms
   landscape maintenance operations
   retail nurseries or garden centers
   mail-order businesses

2. Mail-order businesses generally develop a catalog.

3. "Field stock" refers to plant grown directly in the field. "Container stock" may also be grown in a field, but plants are in some type of container.

4. shade and flowering trees
   broadleaf evergreens
   conifers
   deciduous shrubs
   foliage and house plants
   groundcovers and vines
   fruit trees
   annuals and bedding plants
   perennials

5. budding crew
   tree-trimming crew
   hoeing gang
   farm worker crew

6. knows job well
   has work experience
   enjoys the work
   is capable of working with other people
   is honest
   is willing to assume responsibility
   is imaginative
   has initiative

7. (a) Nurseries are replacing costly, hard-to-find, unskilled labor with machinery. (b) Some nurseries now have employees who design specialized equipment for that nursery.

8. Plant patents encourage the development and improvement of plants by protecting the people who originate new plant forms.

9. (a) New chemicals have proven quite effective in controlling insects, weeds, and other pests. (b) Chemical growth regulators have reduced the need for and the cost of hand labor for pruning, etc.

10. Tissue culture has considerable economic advantage because large numbers of plants can be produced in a short time.

Terms to Remember - page 1-5

1. salaried worker
2. container stock
3. nursery
4. broadleaf evergreen
5. wholesale
6. landscaping
7. narrowleaf evergreen
8. field stock
9. conifer
10. garden center
11. hourly worker
12. retail
13. piece-rate worker
14. landscape maintenance

Crossword Puzzle - page 1-6

ACROSS
3. garden center
4. narrowleaf
6. container
7. field
9. retail
10. maintenance

DOWN
1. broadleaf
2. nursery
5. landscaping
8. conifer

QUIZ

True or False - page 1-12

1. false
2. true
3. true
4. true
5. true
6. true
7. true

Multiple Choice - page 1-12

8. C
9. D
10. B
11. C
12. A
13. B

GLOSSARY - CHAPTER 1

broadleaf evergreen - plant with relatively broad leaves (as opposed to needles) that remain green throughout the year.

conifer - cone-bearing plant with needlelike leaves.

container stock - plants grown in some type of container.

field stock - plants grown in the field as opposed to containers.

garden center - a retail business generally selling plants and related supplies.

hourly workers - workers paid by the hour.

landscape maintenance - caring for established plantings.

landscaping - improving the environment with the design and construction of plantings.

narrowleaf evergreen - plant with needlelike leaves that remain green throughout the year.

nursery - a business which grows woody and/or herbaceous plants.

piece-rate workers - workers (usually temporary) paid by the amount of work they do rather than by the hour.

retail - selling merchandise to consumers as opposed to other businesses.

salaried workers - workers paid a flat rate regardless of the number of hours they work or the amount of work they do.

wholesale - selling merchandise to other businesses rather than to consumers.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 1

T1-1 *(Student Manual*, pages 1-2)

The nursery industry is composed of many types of businesses including: nursery stock producers (some of which are mail-order firms), landscape firms, garden centers, and mass market outlets.

Questions: Which types of nursery firms are located in this area? How would a landscape nursery differ from a nursery stock producer? What is a mass market outlet?

……

T1-2 *(Student Manual*, page 3)

Shade and flowering trees, broadleaf evergreens, and conifers are the major nursery crops produced in the United States. Actually, there are more conifers produced than any other type of plant, but the dollar value in other areas is greater.

Questions: What types of crops are grown by nurseries in this area? Are there any specialty crops grown in this area? Where do you think most of the bulbs, corms, and tubers are produced?

……

T1-3 *(Student Manual*, page 5)

Economically, the Ohio nursery industry is very important. This map of Ohio shows the number of nurseries in each county and the total certified acreage in each county.

Questions: Which counties have the greatest number of nurseries? What factors can help explain the large number of nurseries in these counties?

……

T1-4 *(Student Manual*, page 7)

The interesting part of an organizational set-up such as the one shown here is the way this nursery utilizes its supervisors during the different seasons.

Questions: What are some other jobs in the nursery industry? What are some of the skills you might need to become a supervisor in a large nursery? What kinds of skills would you need to be part of a work crew?

……

T1-5 *(Student Manual*, pages 4-7)

These are some of the tasks you might perform as a nursery worker.

Questions: Which tasks would you enjoy? Why? Which tasks would you dislike? Why?

……

T1-6 *(Student Manual*, page 6)

Nursery supervisors have identified these characteristics as being desirable in a nursery worker.

Question: Which of these characteristics do you have?

……

T1-7 *(Student Manual*, pages 8-10)

Many advances are being made in the nursery industry today. These are just a few of the new trends in nursery operations.

Questions: What are plant patents? Why are they important to the nursery industry? Why is automation important in the nursery industry? Why is the development of new chemicals important to the nursery industry? Why is tissue culture important to the nursery industry? In what ways could computers be used in a large nursery operation?

……

WHOLESALE

- Nursery stock producers

RETAIL

- Nursery stock producers
- Landscape nurseries
  - Design
  - Maintenance
- Garden centers
- Mass market outlets

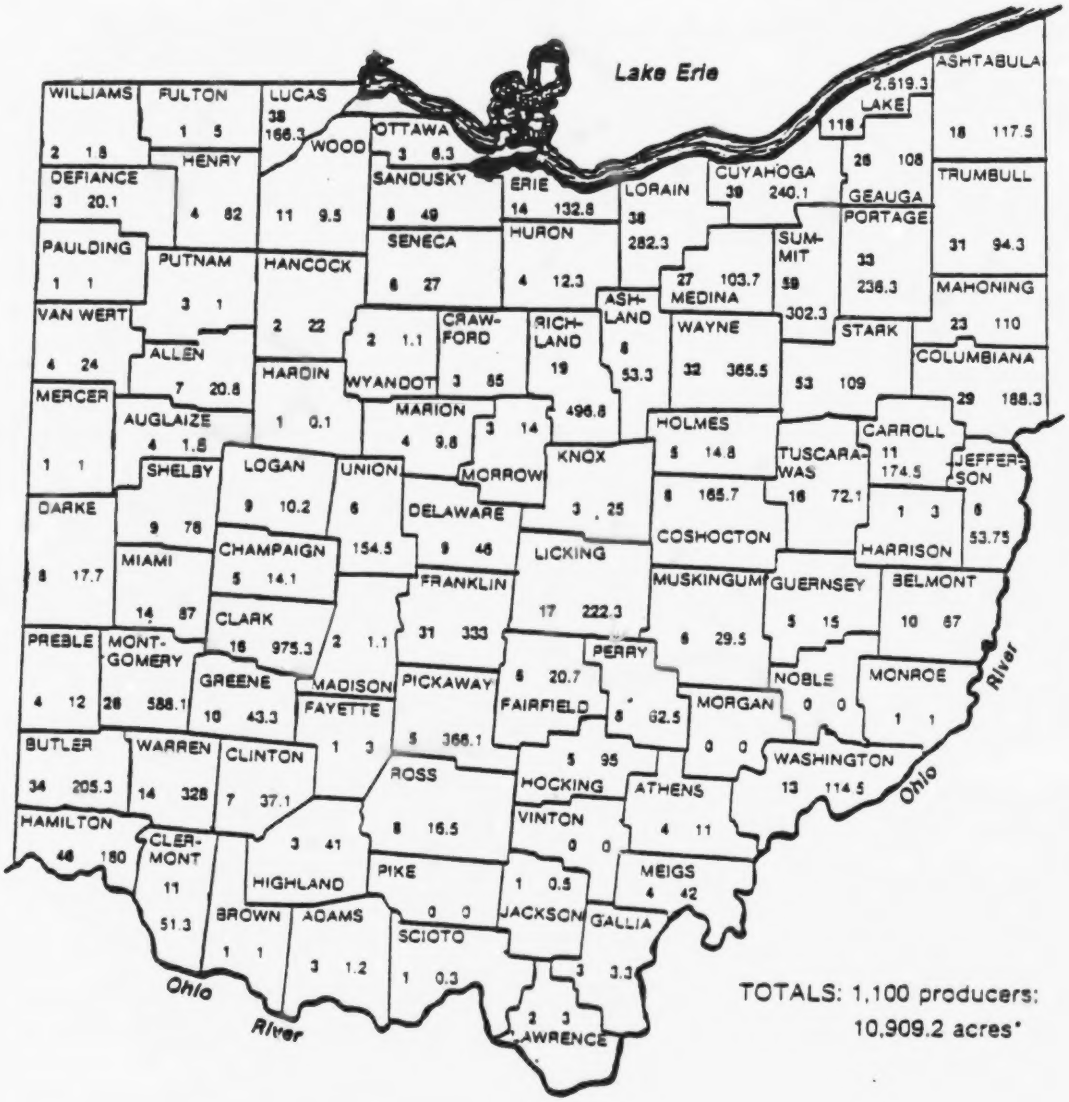
Types of Nursery Crops Produced

CROP	% OF TOTAL SALES
Shade & Flowering Trees	21
Broadleaf Evergreens	20
Conifers	19
Deciduous Shrubs	8
Foliage & House Plants	7
Groundcovers & Vines	6
Fruit Trees	5
Annuals & Bedding Plants	3
Perennials	2
Specialties (Bonsai, etc.)	1
Roses	1
Bulbs, Corms, Tubers	1

OHIO NURSERIES

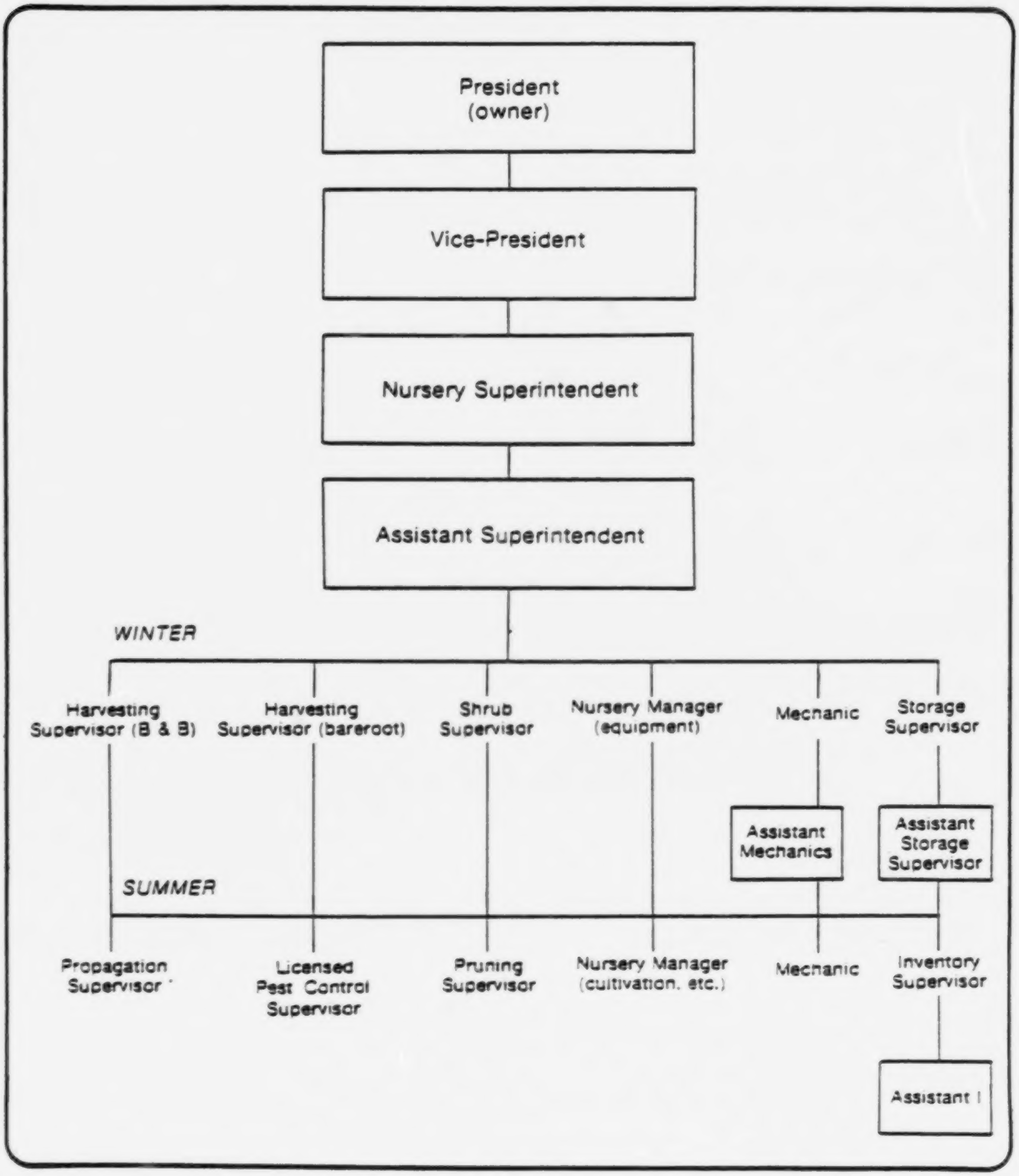
PRODUCERS AND CERTIFIED ACREAGE

1982


Lake Erie
WILLIAMS 2 1.8
FULTON 1 5
LUCAS 38 166.3
OTTAWA 3 6.3
WOOD 11 9.5
HENRY 4 82
DEFIANCE 3 20.1
SANDUSKY 8 49
ERIE 14 132.8
LORAIN 38 282.3
CUYAHOGA 39 240.1
2,619.3 LAKE 118
GEAUGA 26 108
ASHTABULA 18 117.5
TRUMBULL 31 94.3
PORTAGE 33 236.3
SUM-MIT 59 302.3
MEDINA 27 103.7
PAULDING 1 1
PUTNAM 3 1
HANCOCK 2 22
SENECA 6 27
HURON 4 12.3
ASH-LAND 8 53.3
WAYNE 32 365.5
STARK 53 109
MAHONING 23 110
COLUMBIANA 29 188.3
VAN WERT 4 24
ALLEN 7 20.8
HARDIN 1 0.1
WYANDOT 2 1.1
CRAW-FORD 3 85
RICH-LAND 19 496.8
MERCER 1 1
AUGLAIZE 4 1.8
MARION 4 9.8
MORROW 3 14
KNOX 3 25
HOLMES 5 14.8
TUSCARA-WAS 16 72.1
CARROLL 11 174.5
JEFFER-SON 8 53.75
SHELBY 9 76
LOGAN 9 10.2
UNION 6 154.5
DELAWARE 9 46
COSHOCTON 8 165.7
HARRISON 1 3
DARKE 8 17.7
MIAMI 14 87
CHAMPAIGN 5 14.1
LICKING 17 222.3
FRANKLIN 31 333
MUSKINGUM 6 29.5
GUERNSEY 5 15
BELMONT 10 87
CLARK 16 975.3
MADISON 2 1.1
PREBLE 4 12
MONT-GOMERY 26 588.1
GREENE 10 43.3
FAYETTE 1 3
PICKAWAY 5 368.1
FAIRFIELD 6 20.7
PERRY 8 62.5
MORGAN 0 0
NOBLE 0 0
MONROE 1 1
BUTLER 34 205.3
WARREN 14 328
CLINTON 7 37.1
ROSS 8 16.5
HOCKING 5 95
ATHENS 4 11
WASHINGTON 13 114.5
HAMILTON 46 180
CLER-MONT 11 51.3
HIGHLAND 3 41
VINTON 0 0
PIKE 0 0
JACKSON 1 0.5
MEIGS 4 42
BROWN 1 1
ADAMS 3 1.2
SCIOTO 1 0.3
GALLIA 3 3.3
LAWRENCE 2 3
Ohio River
Ohio River

TOTALS: 1,100 producers;
10,909.2 acres*

Organizational Chart for a Large Nursery


President (owner)
Vice-President
Nursery Superintendent
Assistant Superintendent
WINTER
Harvesting Supervisor (B & B)
Harvesting Supervisor (bareroot)
Shrub Supervisor
Nursery Manager (equipment)
Mechanic
Storage Supervisor
Assistant Mechanics
Assistant Storage Supervisor
SUMMER
Propagation Supervisor
Licensed Pest Control Supervisor
Pruning Supervisor
Nursery Manager (cultivation, etc.)
Mechanic
Inventory Supervisor
Assistant I

Tasks of a Nursery Worker

- Plant propagation
- Soil preparation
- Potting/Transplanting
- Fertilizing
- Cultivation
- Pest control
- Pruning
- Harvesting
- Grading
- Storing
- Shipping

Desirable Characteristics of a Nursery Worker

Likes plants
Enjoys working outdoors
Enjoys working with people
Willing to work hard
Honest
Willing to assume responsibility
Showing initiative
Patient
Having sales ability
Businesslike

New Developments in the Nursery Industry

- Plant patents
- Automation/New equipment
- Chemicals
- Tissue culture
- Computers

CHAPTER 2

SOILS

PERFORMANCE CHECK LIST

1. List five factors responsible for the formation of soils.
2. Describe the three horizons found in a soil profile.
3. List the components of soil.
4. List and describe the three types of soil water.
5. Describe the effect of capillary action on water in the soil.
6. Differentiate between wilting point and field capacity in terms of soil water.
7. List and explain the three properties of aggregates relating to soil structure.
8. Describe the effect of organic matter on soil structure.
9. Demonstrate the ability to obtain pertinent information from references for determining soil type and soil characteristics.
10. Define "soil pH."
11. Explain the difference between soil acidity and soil alkalinity.
12. Describe how to adjust pH for both acid and alkaline soils.
13. Explain the effect that soil pH has on nursery plants.
14. Describe how a soil solution is tested to determine pH.
15. Explain the importance of proper drainage for growing nursery crops.
16. List two major types of drainage for nursery crops.
17. Differentiate between sterilization and pasteurization of soils.
18. Differentiate between steam and chemical sanitation of soil.
19. List the characteristics of an ideal soil mix.
20. Describe how soil mixes are prepared.
21. List the functions of a mulch.
22. Describe the effect of raindrop splash on exposed soil.

SUGGESTED LEARNING ACTIVITIES

1. Collect and examine soil samples. Compare various samples and search the soil for living organisms. Analyze the color and texture of your soil samples.
2. Have each student bring a sample of soil from the home garden for analysis of pH and texture.
3. Have students test their own soil samples for drainage.
4. Demonstrate how the addition of soil amendments can improve soil drainage.
5. Examine plant roots and how they grow in soil. Set up an experiment to observe plant growth in various types of soil.
6. Sprout some bean, grass, or radish seeds in a jar. Observe root growth as sprouts develop.
7. With a soil test kit analyze some soil samples for their nitrogen, phosphorus and potassium content. Invite a Cooperative Extension agent or nursery operator to demonstrate usage of such a soil test kit.
8. Set up a demonstration to illustrate percolation of water into the soil. Conduct your experiments using several different soil conditions.
9. Obtain copies of *Conserving Soil*, a publication prepared for the United States Department of Agriculture, Soil Conservation Service, by The Communications and Education Group, a division of the Mazer Corporation. Consult your local Soil Conservation Service or Cooperative Extension Service for availability.
10. Obtain copies of *Teaching Soil and Water Conservation* (PA-341) and *Soil and Water Conservation Activities for Scouts* (PA-978) from the United States Department of Agriculture, Soil Conservation Service. Try some of the experiments found in these bulletins.

SAMPLE INTEREST APPROACH

What would the earth be like without soil? What would cities look like if there were no soil? What would the suburbs and small towns look like? What about farms? How would people raise plants, feed livestock, etc. without soil?

Have you ever heard the expression "Land is a good investment — they're not making any more of it"? Just what does this mean? If you think about it for a few minutes, it is plain that this statement has several things to tell us. It says that the land masses (continents) of the earth will not increase in size to any measurable extent. It says that as the population of the world increases, more of the space that we see as rangeland and cropland will increase in value as people buy it to build homes, factories, and cities. To agriculturists who depend upon the land to produce food, fiber, and other crops, it says that they must be able to produce more on the land they now have.

Why is knowing something about soil so important to nursery operators? Why aren't nursery crops just planted in the field with no regard to soils or soil types? The nursery operator must be aware of the increasing value of land and must take steps to use land in the most effective way possible. Furthermore, anyone who wants to make a profit in the nursery business must grow crops efficiently. Good soils produce high quality crops. Knowing what makes a soil good or how to make a poor soil better can help make you a better horticulturist.

NAME ______________________

KEY QUESTIONS FOR CHAPTER 2

PART 1

Soil Formation

1. Why are soils important to nursery operators? (page 11)

2. Define "soil." (page 11)

3. How is soil formed? (pages 11-14)

4. List five factors responsible for soil formation. (pages 11-14)
   1) ______________________
   2) ______________________
   3) ______________________
   4) ______________________
   5) ______________________

5. List the three major groups of parent materials. (page 12)
   1) ______________________
   2) ______________________
   3) ______________________

6. How did glaciers affect soil formation? (page 12)

7. How does climate affect soil formation? (page 13)

(continued)

Part 1 *(continued)*

8. How do plants and animals affect soil formation? (pages 13-14)

9. What is topography? (page 14)

10. How does topography affect soil formation? (page 14)

11. How does time affect the formation of soils? (page 14)

12. How does time affect soils after they have been formed? (page 14)

13. What is "leaching"? (glossary)

PART 2

Soil Profiles

1. What is a soil profile? (page 15)

2. List and describe the three horizons found in soil. (pages 15-16)

3. What is topsoil? (page 16)

4. What is subsoil? (page 16)

5. What is the solum? (page 16)

Soil Components

6. What is humus? (page 16)

7. List three ways organic matter affects soils. (page 16)

   1)

   2)

   3)

(continued)

Part 2 (continued)

Soil Water

8. How do hygroscopic water, capillary water, and gravitational water differ? (pages 17-18)

9. How can you tell that a soil has reached the saturation point? (page 18)

10. What is field capacity? (page 18)

PART 3

Soil Texture

1. What is soil texture? (page 19)

2. What is loam? (page 19)

Soil Structure

3. What is soil structure? (page 21)

4. What is an aggregate? (page 21)

Soil Types

5. List eight types of soil structure. (page 21)

1) ____ 5) ____

2) ____ 6) ____

3) ____ 7) ____

4) ____ 8) ____

6. What is soil tilth? (pages 16 and 22)

7. How can soil tilth be improved? (page 22)

Soil Acidity and Alkalinity

8. What is soil pH? (pages 25-26)

(continued)

Part 3 *(continued)*

9. What is a neutral soil? (page 25)

10. How does soil pH affect plant growth? (page 26)

11. How can soil acidity be reduced? (page 26)

12. List five materials which can be used to reduce the acidity of soils. (page 28)

    1) ____________________

    2) ____________________

    3) ____________________

    4) ____________________

    5) ____________________

13. How can you adjust the pH of an alkaline soil? (page 29)

PART 4

Drainage

1. What are some possible effects of too much water on plants? (page 29)

2. What is drainage? (pages 29-30)

3. What is the difference between soil sterilization and soil pasteurization? (page 34)

4. What is soil fumigation? (page 36)

5. How is soil pasteurized? (page 34)

6. What is one problem associated with steaming soil? (pages 34-36)

7. What happens when all the nitrifying soil bacteria are killed? (page 36)

PART 5

Soil Mixes

1. What are four characteristics of an ideal soil mix? (page 37)
   1) ______
   2) ______
   3) ______
   4) ______
2. What is the bulk density of a soil? (page 37)

   ______

   ______
3. Why is the cation exchange capacity of a soil important to plant growth? (page 37)

   ______

   ______

   ______

   ______
4. List four advantages of using hardwood bark as a potting mix ingredient. (page 37)
   1) ______
   2) ______
   3) ______
   4) ______
5. List three advantages associated with the use of peat as a potting mix ingredient. (page 38)
   1) ______
   2) ______
   3) ______
6. List two advantages of using perlite as a potting mix ingredient. (page 38)

   ______

   ______
7. List two advantages of using vermiculite in potting mixes. (page 38)

   ______

   ______

PART 6

Mulch

1. What is a mulch? (page 39)

2. List six functions of a mulch. (pages 39-40)

   1)

   2)

   3)

   4)

   5)

   6)

Soil Conservation

3. How can soil be renewed? (page 40)

4. What is a green manure crop? (page 40)

5. What is a cover crop? (page 40)

6. What is the major purpose of a soil-building crop? (page 40)

NAME ____________________

TERMS TO REMEMBER - Chapter 2

PART I

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 2 of *The Nursery Worker*.

Technical Vocabulary

aggregate
agronomy
bulk density
capillary water
cover crop
hygroscopic water
loam
metamorphic rock
mottled
mulch
parent material
pasteurization
sedimentary rock
soil-building crop
solum
subsoil
topography
topsoil
vermiculite

__________ 1. Any loose and dry material used as a thin protective covering over the soil. (page 39)

__________ 2. The combination of **A** and **B** horizons. (page 16)

__________ 3. The weight of soil. (page 37)

__________ 4. A lightweight, expanded-mica product often used as a rooting medium for plants or as a soil amendment. (page 38)

__________ 5. A group of soil particles. (page 21)

__________ 6. The **C** horizon of soil. (page 16)

__________ 7. Water or moisture strongly attached to soil particles. (page 17)

__________ 8. Rock formed by the deposition of sediment. (page 12)

__________ 9. The science of soil management. (page 23)

__________ 10. Water that is available to plants. This water is held more tightly to the soil particle than the pull of gravity, but is weak enough to allow it to be used by plants. (page 17)

__________ 11. Soil below the usual depth of cultivation, containing little or no humus, and characteristically more dense than topsoil. (page 16)

__________ 12. Rock formed through a process of change caused by pressure or heat. (page 12)

__________ 13. A crop which helps to maintain the tilth and prevent losses of the soil that is present. (page 40)

__________ 14. The **A** horizon of soil. (page 15)

__________ 15. Spotted or blotched in coloring. (pages 32, 34)

(continued)

Terms to Remember - Part 1 *(continued)*

____________________ 16. A herbaceous crop sown to cover the ground temporarily and thus protect it from erosion. (page 40)

____________________ 17. The lay of the land. (page 14)

____________________ 18. Exposing soil to a high temperature to destroy certain microorganisms. (page 34)

____________________ 19. A soil containing a relatively equal mixture of sand, silt, and clay. (page 19)

NAME ______________________

TERMS TO REMEMBER - Chapter 2

PART 2

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 2 of *The Nursery Worker*.

Technical Vocabulary

erosion
field capacity
fumigation
gravitational water
green manure crop
horizon
igneous rock
infiltration
leaching
peat
perlite
pH
saturation point
soil
soil profile
soil structure
soil texture
sterilization
tile drainage

______________________ 1. The internal drainage of a soil through the use of buried concrete or clay pipes. (pages 30-31)

______________________ 2. The process of making a soil free of all harmful organisms, by heat, steam, or fumigation. (page 34)

______________________ 3. The process of wearing away of rocks and soil by natural agents. (page 13)

______________________ 4. Water that is free to move through a soil mass under the influence of gravity. (page 18)

______________________ 5. Decomposed bog plants. (page 38)

______________________ 6. The washing out of soluble materials from the soil. (glossary)

______________________ 7. The size of soil particles and proportion of sand, silt, and clay in a soil. (page 19)

______________________ 8. Treatment of soil, plants, or a greenhouse with a gas, smoke, or vapor to rid it of pests. (page 36)

______________________ 9. A lightweight, granular material made out of a volcanic mineral treated by heat and water so that it expands like popcorn. (page 38)

______________________ 10. The amount of water the soil can hold after draining off excess gravitational water. (page 18)

______________________ 11. A symbol used in expressing both acidity and alkalinity. (page 25)

______________________ 12. A cover crop which is plowed under while still green to improve the soil. (page 40)

______________________ 13. A natural layer on the earth's surface in which plants grow. (page 11)

(continued)

Terms to Remember - Part 2 *(continued)*

____________________ 14. The point at which a soil cannot hold anymore moisture. (page 18)

____________________ 15. Rock produced under intense heat, as rocks of volcanic origin. (page 12)

____________________ 16. A layer of soil which differs in composition and/or structure from adjacent layers. (page 15)

____________________ 17. Filtering into or through the soil. (page 30)

____________________ 18. A diagram of the vertical section of a soil showing the thickness and character of the various soil horizons. (page 15)

____________________ 19. The arrangement of the mineral particles in the soil. (page 21)

Crossword Puzzle 2A - Clues

ACROSS Clues

3. Rock formed by sediment deposits. (page 12)
5. A type of drainage system. (page 31)
6. Killing some but not all organisms in the soil. (page 34)
10. The A and B horizons together are referred to as the ______ (page 16)
11. The rock from which soil is formed is called ______ material. (page 11)
13. Soil science. (page 23)
17. Rock formed through a process of change caused by pressure or heat. (page 12)
20. The lay of the land. (page 14)
21. The A horizon is often referred to as ______ soil. (page 15)
22. The washing away of soil. (page 13)
23. A soil containing a mixture of sand, silt, and clay in relatively equal proportions. (page 19)
24. The gradual movement of water into the soil. (page 30)

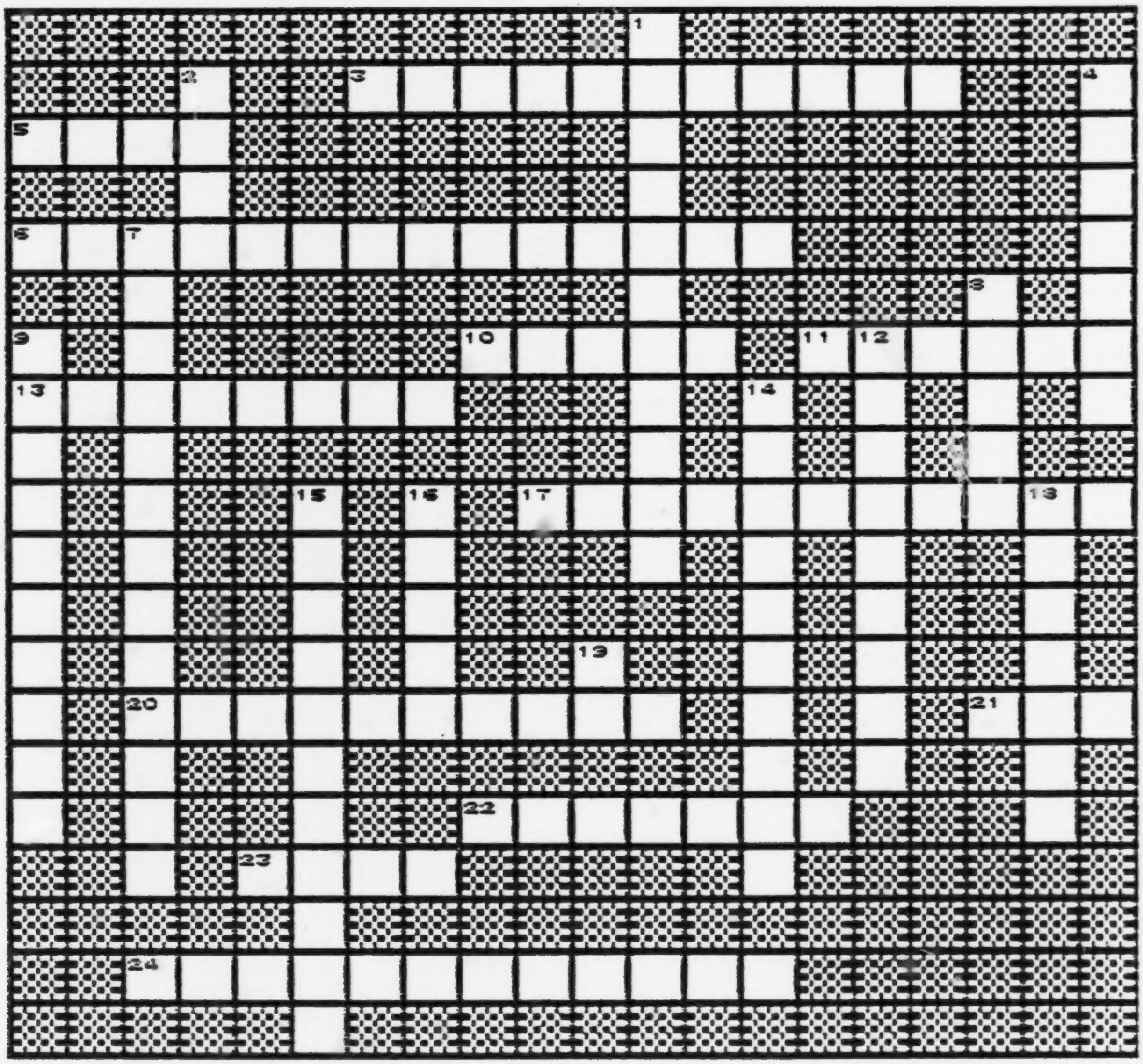
DOWN Clues

1. Expanded mica. (page 38)
2. Organic soil additive derived from decayed bog plants. (page 38)
4. Expanded volcanic rock used as a soil amendment. (page 38)
7. Killing all organisms in the soil. (page 34)
8. To flush the soil with large amounts of water. (glossary)
9. The point at which all soil pores are filled with water. (page 18)
12. A group of soil particles. (page 21)
14. Treatment of the soil with a gas to destroy pests. (page 36)
15. Water held to soil particles so tightly that plants cannot use it. (page 17)
16. A ______ crop is sometimes planted to prevent soil erosion. (page 40)
18. Rock produced under intense heat, as rock of volcanic origin. (page 12)
19. A measure of acidity and alkalinity. (page 25)

NAME ______________________

CROSSWORD PUZZLE 2A

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker*.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

Crossword Puzzle 2B - Clues

ACROSS Clues

1. Killing some but not all organisms in the soil. (page 34)
5. A type of soil water which is available for plant use. (page 17)
6. Soil science. (page 23)
7. The layer beneath topsoil is called ______ soil. (pages 15-16)
8. To apply large amounts of water. (page 37)
11. Rock produced under intense heat, as rocks of volcanic origin. (page 12)
13. The lay of the land. (page 14)
14. Rock formed by sediment deposits. (page 12)
17. A layer in a soil profile. (page 15)
18. The A and B horizons together form the ______. (page 16)
19. A measure of acidity and alkalinity. (page 25)
21. The size of the soil particles. (page 19)
22. A mixture of sand, silt, and clay. (page 19)
23. Green ______ crops are plowed under to add organic matter to the soil. (page 40)
24. Soils with several distinct colors are said to be ______. (pages 32, 34)

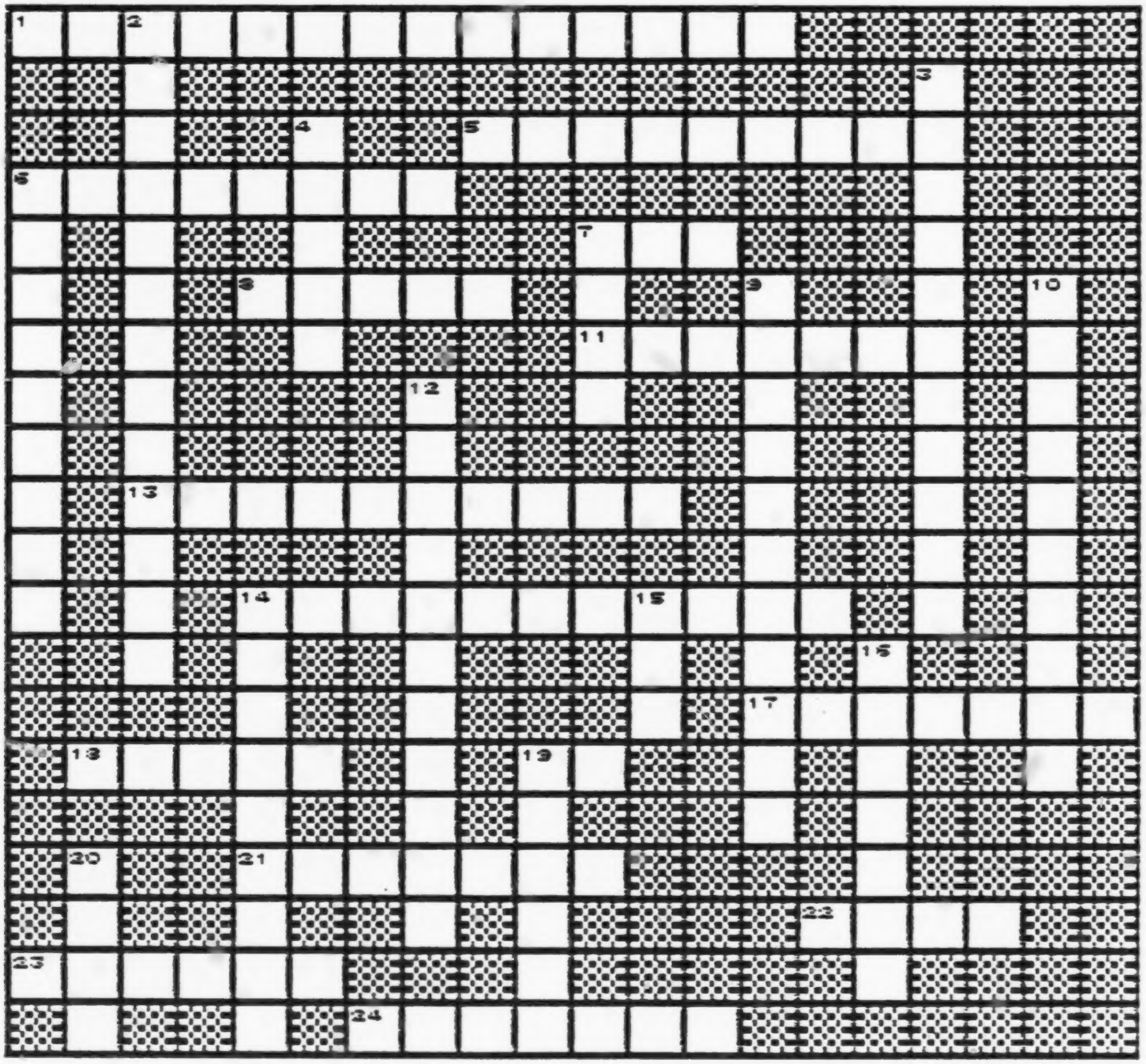
DOWN Clues

2. Killing all organisms in the soil. (pages 34-36)
3. Water so tightly bound to soil particles that plants cannot use it. (page 17)
4. A ______ crop is sometimes planted on bare soil to prevent erosion. (page 40)
6. A group of soil particles held together. (pages 21, 22)
7. The productive portion of the earth's crust. (page 11)
9. Rock formed through a process of change caused by pressure or heat. (page 12)
10. Sanitizing the soil with a gas. (pages 34, 36)
12. Expanded mica. (page 38)
14. The terms *blocky*, *prismatic*, and *platy* all refer to types of soil ______. (page 21)
15. Another name for the A horizon is ______ soil. (page 15)
16. The washing away of soil. (page 13)
19. Rocks from which soil is derived:— ______ material. (page 12)
20. Organic material composed of decayed bog plants. (page 38)

NAME ______________________

CROSSWORD PUZZLE 2B

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker*.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

NAME ____________________

LETTER MAZE 2A

The 20 words listed below are hidden in the letter maze. Can you find them? They may be written across, down, or diagonally. When you find a word, circle it.

```
N S H M A Q D X U E E X E D R V P G D X S Q Z C T Y X R L Z H H
L E U X O T Y R Z I H U T A L Y S R T W X O S T S L Q T O Z U E
V U E B X V P D I R H Q Y E R O S I O N P E R L I T E N T R G G
H L G P S L L S L U N K C X J R O F U O N O N T U G V J H Z L U
I G E Z Y O S S E U G L U C L Q P H C K M T C B H V Q O D J U J
O T F E C T I Q A J I X X D O Z P E O I Y P V T G X Z I K I Q L
P H W Y J K M L C U S G W R E T I T W A R U A E I I C C B A B K
U E J K W H C V H N U S C C O A U Y Y Q W P H L O S K G S K S I
O Y A C O K B I L J X V Y H K E C Z Q N F V N M I E D E Y G O F
K R E T P W A B V W K W I Q T P V V D G A O Q D G D E H J H L I
E R Q L A A G A Q S V O A I M R O A X U Z B B G B I D X L J U N
P S O M S G S C O R Z C L P O P P T H I X H D S Q M E B H S M F
V I C V T R M I E U K U A T F G R E R U P I S R J E C C R D E I
V A R W E T W B G V C V G A T W G O J Q Y T S N U N J O Z Q K L
W G O Y U T T Y J I A E X W O K H M Q R N O A D B T R R V B K T
A F J V R H X F M V E C E C P R P B L Y A P X T X A Z L V A Z R
G U G S I H H R X S G Z G E S G T K Y W X O U H L R F O Y P C A
R X P F Z C E Q Y K Y R T Q O T M R B Q X G L V A Y L N H Y M T
O O F D A V L Y X J G J L X I M E L A P W R W G B H K G Y D L I
N F K B T S U R M S I L G P L I Y R H O U A O F O W V I D K Y O
O U I S I D Z Z H F W N J F M I X P I D U P A G G R E G A T E N
M M S G O T A R C O T I K X A Y T Y Y L F H R P J I T Y Q Z O I
Y I T L N G N X R A J O D I P X V T J L I Y J O W N L W H B V G
X G T K D E P F C A H Y V V U Y M U L C H Z J H K H H W S A D C
T A X I N B O F H X D H X H V K C O E B W L A C Z J I S H O I O
R T U S B W P U M J J F O E Z I P N M V E U D T C I M K Q Y F O
U I L O R C B X S J D M Z Y Z M I X U E E E H H I A I S M Z T W
V O J U H B M N T C L P W P Z E J M W J J H W Q O O S O S C F G
W N Y S M O D K G R G U Y W O J X F V F E W A L V M N B N K M E
```

AGGREGATE
AGRONOMY
EROSION
FUMIGATION
HORIZON
IGNEOUS
INFILTRATION
LEACH
LOAM
MULCH
PASTEURIZATION
PEAT
PERLITE
SEDIMENTARY
SOLUM
STERILIZATION
SUBSOIL
TOPOGRAPHY
TOPSOIL
VERMICULITE

NAME ____________________

LETTER MAZE 2B

The 21 words listed below are hidden in the letter maze. Can you find them? They may be written across, down, or diagonally. When you find a word, circle it.

L N V W I E F M V U J P Y M I M P J F B B K H R T D O I G M Y O
K N O S N D S Y E A P E M B R Q E W L P Z O O K R N W Z E P V B
Y N J I E P X W D T V Q A O P L R Y V L C Y B G H L W K T V B H
D Y D K Z I I X C L A A X G J X H Q G A K Z T E V G O O H N U E
F T D K M Q V Q L B K M Y Y G M L V F I A U J L I Y F R W D W X
Z L S A N L S A H Z Y D O A T O S E T G D V V N P S X Y S T B I
G N O Z W T S E N I P E V R K L S H A N I T Y W O O N V P R K V
L L A W Q J C K D B A E W I P L O J X C M O W C E N O B N X A Z
X J J O J X S P H I W C S W D H J L Y N H D K Y I J U D Q P Y P
B P F D P Y D T V X M Z Y H O R I Z O N J S S E P S L U N A C I
F K U G G E Q I E U T E P D O O S C K F J W U Y Q F K X B S H M
N U M T F P U D M R P A N Q R Q J A L K A A B P R P H F R T A I
P Q I A O K G A I O I E T T I E Q P X B Y Y S E C B C R H E I O
Y G G V K P I F Q N B L V S A I C T S W H K O A D U Y W O U J E
K V A E J F S K E D F U I J H R P V D P K W I T M M X Q R R C F
S D T H D L X O X R U I G Z Z T Y U A T B S L G O P E R L I T E
O E I D I P G I I Q O Y L M A U D R L G T E L N S L O F I Z O G
L S O W G B E C D L S S M T L T G E K W T T O N J Q W N J A H R
U N N A G G R E G A T E I N R O I E R J N R I G N E O U S T Q R
M I E V T W F B Y Q D O P O P A O O B D G A Z K V N W Q I I G D
B T G Y O R U V V H D T F O N B T X N A K V U I B J X U E O D O
S V O S U X K Z D L Z K T W J O L I Z I Y M V C V C D T O N K M
N H I P Q V F Q B D O F Q A W Y B Y O G V Q E D I J G H Q B E H
C A G S H L N X O U L Y T D Y Y Z L R N G H R B Z F Z Q R E F M
L T Q T L Z M Z G K W D J T O V N U E H W Z M O L D I R I A F Z
F I N H O P I O V T L J H J W I H G T Z M B I Y F F B X I S R V
H R C H L F A A V F X T Z I T C B I J J N I C L U P O P F B X D
F V W P M H N A R S T X I J N V J U G Z Z X U W P N N R I I G R
Q S D X V V O G B J E Z I P J Z E S U H C X L Z R G R N E C C M
A L V X W R F V X H B M A K M H Z Z V S A X I H B O N I C O K W
F G M Q Q G G V D O V I A W B G E F A D O O T J F R X C I K T S
O D C X E U M U L C H L X G T D K I T H E T E T D J R Y J F G S

AGGREGATE
AGRONOMY
EROSION
FUMIGATION
HORIZON
IGNEOUS
INFILTRATION
LEACH
LOAM
METAMORPHIC
MULCH
PASTEURIZATION
PEAT
PERLITE
SEDIMENTARY
SOLUM
STERILIZATION
SUBSOIL
TOPOGRAPHY
TOPSOIL
VERMICULITE

NAME ____________________

STUDENT EXERCISE 2-A

DETERMINING IF ALL SOIL PARTICLES ARE THE SAME SIZE

This exercise helps to demonstrate the ability to identify the various sizes of soil particles.

MATERIALS:

- one-quart Mason jar
- sample of soil
- piece of cardboard

PROCEDURE:

1. Fill the Mason jar about two-thirds full of water. Pour in soil until the jar is almost full. Replace the cover or put one hand tightly over the top of the jar and shake it vigorously. Then put the jar on the table and let the soil settle. Allow plenty of time because the very small particles will be slow in settling.
2. Hold the cardboard against the side of the jar and draw a diagram showing the different layers that have settled (Figure 2-1). The larger particles at and near the bottom are the sand particles. The finer particles directly above the sand are the silt particles. The top layer of very fine particles consists of the clay in this soil.

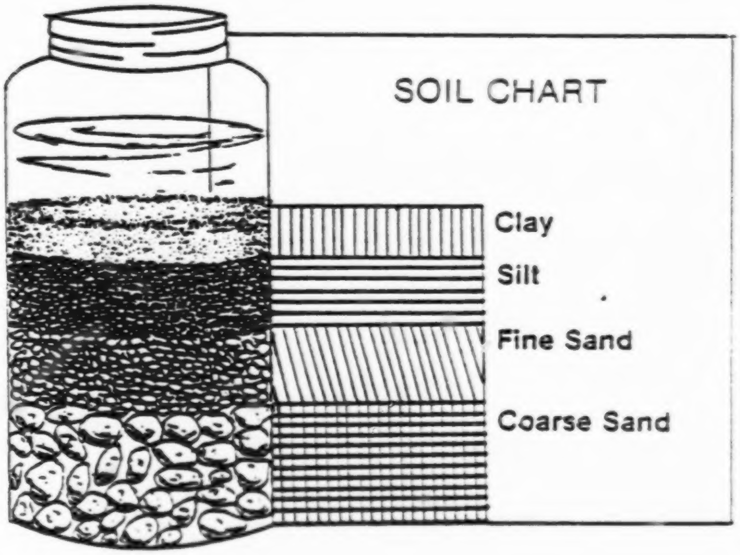


Figure 2-1. Diagram showing different layers of soil.

(continued)

Student Exercise 2-A *(continued)*

INTERPRETATION:

It should be evident from this exercise that soils are made up of particles of different sizes. This is true with every soil. Based upon the size of particles, you can classify soils according to their texture. Texture, then, refers to the size of soil particles. The particles are measured in millimeters. (A millimeter is 0.001 meter, and a meter is approximately 39 inches.) They are classified according to the following chart:

very coarse sand	2.0 to 1.0 mm
coarse sand	1.0 to 0.5 mm
medium sand	0.5 to 0.25 mm
fine sand	0.25 to 0.10 mm
very fine sand	0.10 to 0.05 mm
silt	0.05 to 0.002 mm
clay	smaller than 0.002 mm

The size of soil particles is important to the study of soils, and the relationship of plants to various soils. The amount of space between the particles has a lot to do with how easily water moves through a soil and how much water it will hold.

A soil with too much clay, in proportion to silt and sand, takes in water very slowly. The clay particles are the smallest, causing the pore spaces to be smaller. Such a soil also gives up its water to plants slowly and is very sticky when wet.

Loam and **silt loam** refer to soils that have a favorable proportion of sand, silt, and clay. A loam, by definition, contains 1/3 sand, 1/3 silt, and 1/3 clay. A silt loam contains no more than 50 percent sand and no more than 27 percent clay. The rest, naturally, is silt.

Size of soil particles (texture) also affects the ease of working the soil, what crops can be grown, and the efficiency of certain fertilizers. Sandy soils that have very little clay or silt particles filling the pore spaces cannot hold as much moisture. The pore spaces are larger and the gravitational forces pull most of the water through the soil. For this reason, medium and coarse sandy soils low in clay are known as droughty soils. Crops cannot live long in them without very frequent rains or irrigation.

EVALUATION:

1. The exercise was completed as directed. ______________
2. All materials and equipment were cleaned and stored properly. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 2-B

DETERMINING SOIL TEXTURE BY FEEL

After you have finished this exercise, you should be able to demonstrate the ability to determine soil texture by feel as well as by mechanical analysis using the textural triangle.

MATERIALS:

- several soil samples (each from a different location)
- small container for water

PROCEDURE:

First observe the dry samples and note the following characteristics:

A. Soils high in sand are seldom cloddy. They usually break apart easily.

B. Soils high in silt may be cloddy, but usually break suddenly to a soft powder showing a fingerprint.

C. Soils high in clay are usually cloddy. The dry granules are often hard to break even with pressure.

Although you can determine some general characteristics of the soils by dry observation, a more accurate analysis can be made only by using a moist sample.

Take about a half a tablespoon of one of the soils. Moisten it gradually with a small amount of water. Knead it vigorously until all the dry lumps have been wetted. Increase the amount of soil if too much water is used. When all the soil is moist, test the ease of forming a ball, then try to squeeze the soil into a ribbon by working it between the thumb and forefinger (Figure 2-2). Soils high in sand will feel gritty and will not make a good ribbon. Soils high in silt feel smooth and velvety, or floury. They usually show a fingerprint clearly. They may form a short ribbon (depending upon the amount of clay in the sample). Soils high in clay can often be pressed out into very thin ribbons two or more inches long.

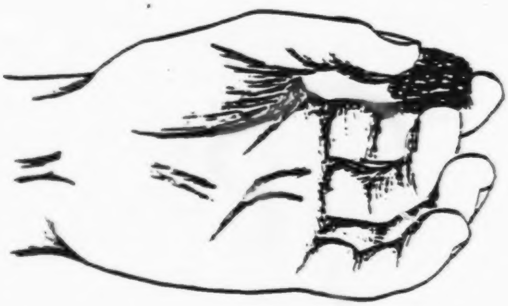


Figure 2.2. Attempting to form a ribbon to determine the soil texture

Test several samples in the above manner. Attempt to name the texture of the soil according to the textural class characteristics in the following chart. Number the samples you identify and record your estimate of each sample on the form provided. Give these results to your instructor so he/she can check your classifications.

(continued)

Student Exercise 2-B *(continued)*

Results of Determining Texture By Feel

NO.	SOIL TEXTURE	PRIMARY & SECONDARY CHARACTERISTICS
1.		
2.		
3.		
4.		
5.		
6.		
7.		

The exercise you have just completed has given you a quick method for identifying the texture of a soil under field conditions. With practice, you can become fairly accurate with this method. However, there are other ways of testing your accuracy under laboratory conditions. You can become more confident as you gain experience.

EVALUATION:

1. Some general characteristics of the soil were determined by dry observation. ______________
2. The texture of several soil samples was determined by feel. ______________
3. The chart (above) was completed neatly and accurately. ______________
4. All materials and equipment were cleaned and stored properly. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 2-C

MECHANICAL ANALYSIS OF SOILS

The objective of this exercise is to measure the amounts of sand, silt, and clay in soils using a mechanical analysis procedure.

MATERIALS:

- soil samples from Exercise 2-B
- 3 quart Mason jars
- 8% Calgon solution (mix 6 tablespoons of Calgon per quart of water)
- ruler
- cardboard pieces

At this point, you should be able to identify the texture of soils by feel. You are able to feel the relative proportions of sand, silt, and clay in soils to make your decision. In this exercise you will be using a mechanical method to measure the amounts of sand (including fine gravel, coarse sand, and fine sand), silt, and clay in the soil. You will also be applying this information to a soil triangle to determine the texture. The success of this exercise depends upon your ability to separate these particles so you can accurately measure them.

PROCEDURE:

1. Place approximately one-half cup of one of the soils in a quart jar. Add five tablespoons of the 8% Calgon solution and three and one-half cups of water to the soil. Cap and shake for five minutes. Place the jar on a desk or table and let stand for 24 hours.
2. At the end of 24 hours, measure the depth of settled soil. This represents the total depth of the soil. Then shake thoroughly for five minutes. Place the jar on the desk and let it stand for 40 seconds. Now measure the depth of settled soil with a ruler. This is the sand layer. Record this depth.
3. At the end of 30 minutes measure the depth of settled soil and subtract the depth of sand from this depth to get the depth of the silt layer. Record this figure.
4. The remaining unsettled part represents the clay fraction. Record this figure.

Results of Mechanical Analysis

	SOIL #1	SOIL #2
a. Total depth of soil	______	______
b. Depth of sand layer	______	______
c. Depth of silt layer	______	______
d. Depth of clay layer (a - [b - c])	______	______

The measurements may be converted into percentage figures according to the following examples:

	SOIL #1	SOIL #2
a. Total depth of soil	23 mm	35 mm
b. Depth of sand layer	9 mm	13 mm
c. Depth of silt layer	10 mm	10 mm
d. Depth of clay layer	4 mm	13 mm

(continued)

Student Exercise 2-C *(continued)*

To find the percentage of sand:

Soil #1 $\frac{9\text{ mm}}{23\text{ mm}} \times 100 = 39\%$

Soil #2 $\frac{13\text{ mm}}{35\text{ mm}} \times 100 = 37\%$

To find the percentage of silt:

Soil #1 $\frac{10\text{ mm}}{23\text{ mm}} \times 100 = 43.5\%$

Soil #2 $\frac{10\text{ mm}}{35\text{ mm}} \times 100 = 28.5\%$

You can follow the same procedure to find the percentage of clay, or you can subtract the percentages of sand and silt from 100%, as below:

Soil #1 100% - 82.5% = 17.5% clay

Soil #2 100% - 65.5% = 34.5% clay

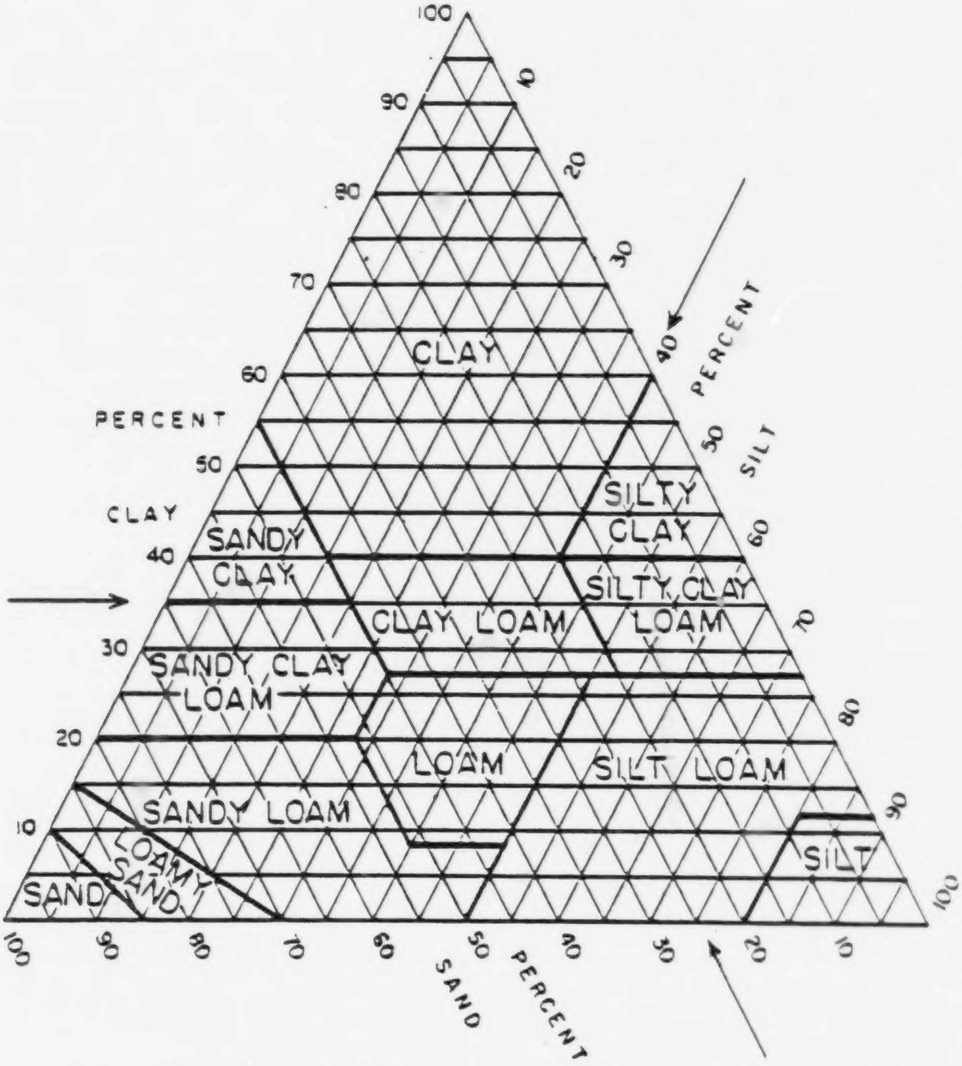

PERCENT CLAY
PERCENT SILT
SAND PERCENT
CLAY
SANDY CLAY
SILTY CLAY
SILTY CLAY LOAM
CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
LOAMY SAND
SAND
SILT
100
90
80
70
60
50
40
30
20
10

Figure 2-3. THE TEXTURAL CLASSIFICATION TRIANGLE

(continued)

Student Exercise 2-C *(continued)*

How to Use the Textural Classification Triangle

Locate "percent sand" along the bottom of the triangle (Figure 2-3). Follow from this point **up and to the left**, parallel with the right side of the triangle. The percent sand is constant anywhere along this line. Locate "percent clay" along the left side of the triangle and follow from this point **horizontally across** to the right. The textural class for the soil is shown in the area where the sand and clay percentages cross. Check the accuracy of this point by locating "percent silt" along the right side of the triangle and follow **down and to the left**. The percent silt should meet the intersection of the sand and clay percentages.

Using the same soil triangle (Figure 2-3), determine the textural class of each soil you measure. For the example problems on the previous page, Soil #1 turned out to be a loam. Check this answer on the soil triangle and see if you come out with the same answer. If not, your instructor can show you where you might be reading the triangle wrong.

EVALUATION:

1. The exercise was completed as directed. ______________
2. All materials and equipment were cleaned and stored properly. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 2-D

ORGANIC MATTER AND SOIL STRUCTURE

The objective of this exercise is to determine the effects of organic matter on soil structure.

MATERIALS:

- 2 wide-mouth glass jars
- 2 small wire baskets of ¼-inch hardware screen
- lumps of soil
- water

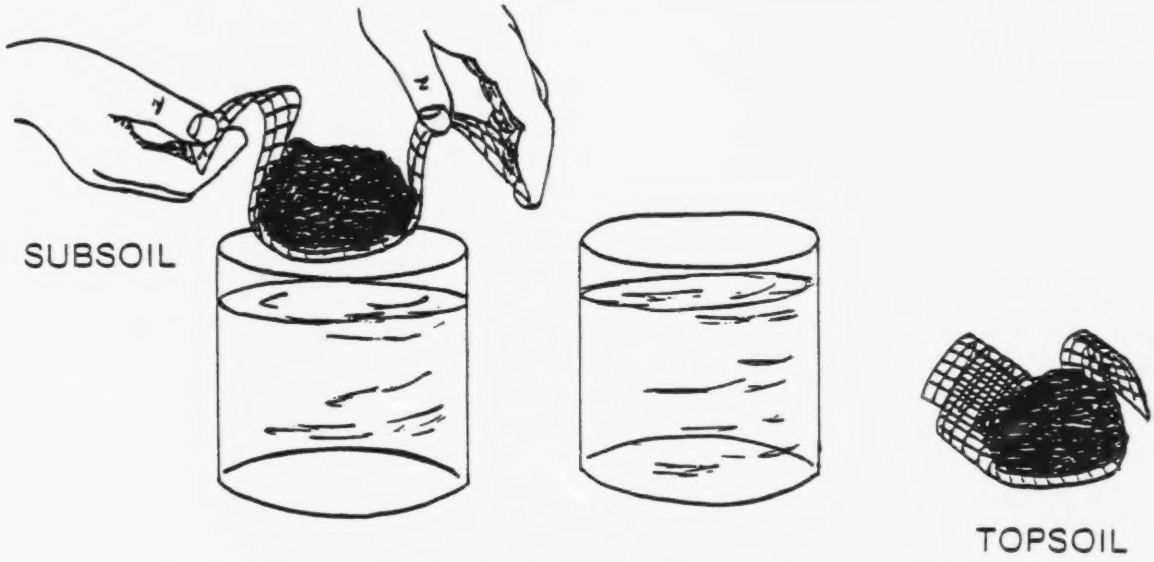


Figure 2-4. Wide-mouthed jars and the shaping of hardware screen to go into them.

PROCEDURE:

1. Make two small baskets or wire racks of the ¼-inch hardware screen to fit into the wide-mouthed glass jars.
2. For each rack you will need a piece of screen about 3 X 10 inches. Bend the wire as shown in Figure 2-4 so that it extends, basketlike, down into the jars.
3. Collect lumps of soil (not sandy soil) just under the sod from: (a) a natural sod fence row or park, and (b) a cultivated field that has been cropped continuously, the soil of which is light in color. These lumps should be about twice the size of an egg.
4. Fill the jars with water to within an inch of the top.
5. Place the lumps of soil in the baskets and lower them gently into the jars.
6. Watch them closely and make notes of what happens.

(continued)

Student Exercise 2-D *(continued)*

INTERPRETATION:

Why does the soil from the heavily cultivated field fall apart and drop to the bottom of the jar while the other one holds its shape and clings together? The answer is largely the difference in the amount of organic matter and the effect it has on the soil.

Organic matter has a marked effect on both physical and chemical properties of soils. It helps soil hold water and, therefore, decreases the amount of water that runs off. It improves aeration, especially on the finer textured (heavier) soils. And it makes the soil easier to work - improves soil tilth.

While these are related, improving soil tilth is the one most clearly illustrated in this simple activity. Organic matter improves tilth of soils - makes the soil crumbly — causing the individual soil particles to stick together tightly in granules. These granules, in effect, act much like larger particles, letting water and air move through the soil more readily. The large granules tend to stick together, too, because of the binding effect of the decomposed organic matter, or humus, and because of tiny roots under sod layers.

Since organic matter reduces water-runoff losses, damage by water erosion is greatly reduced.

When raindrops strike a bare soil that has little organic matter content, the soil particles are easily separated and readily washed away. In this exercise the sample from the heavily cultivated field shows what can happen to a soil during a heavy rain.

EVALUATION:

1. The exercise was completed as directed. ______________
2. All materials and equipment were cleaned and put away. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 2-E

DETERMINING SOIL PERMEABILITY

This exercise will help you learn how to determine the permeability of different kinds of soil.

MATERIALS:

- sample of a sandy soil
- sample of a loamy soil } (All three should be air dried and crumbled to about 2mm)
- sample of a clay soil
- three 1-gallon cans with holes punched in the bottom OR three lamp chimneys
- three pieces of window screen to place in the bottom of each can OR three pieces of cheesecloth to tie onto the lamp chimneys
- three measuring jars to hold water
- three beakers to hold the water that passes through the soils
- three stands for the gallon cans (if cans are used)

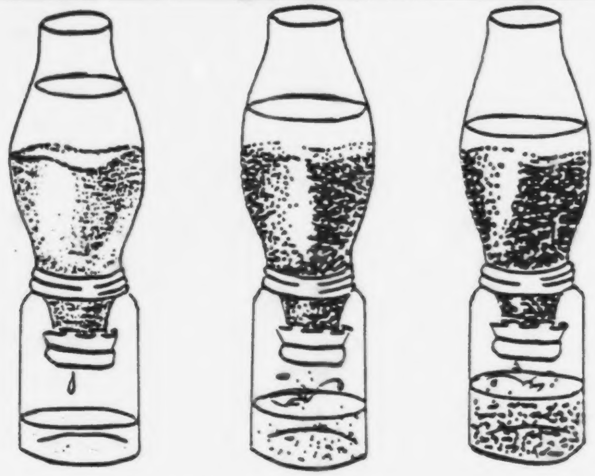


Figure 2-5. Lamp chimneys set in jars

PROCEDURE:

1. Lightly place each soil into its can or lamp chimney, filling each to the same level.
2. Fill in the measuring jars with water to the top level.
3. Place the cans of soil or lamp chimneys over the collecting beakers (Figure 2-5).
4. Pour water from the measuring jars, flooding the surface of the soils first, then slowly adding water to the moist surface until the cans begin to drip.
5. Measure the amount of water added and the time required for the water to begin dripping.
6. Note the bubbles of air rising through the soil as water is added.
7. Finish adding the water to the soils.
8. Measure the amount of water that has passed through the soils.
9. Record your observations in the chart which follows.

(continued)

Student Exercise 2-E *(continued)*

	Time Dripping Began	Amount of Water Added	Time Dripping Stopped	Amount of Water in Beaker
SAND				
LOAM				
CLAY				

QUESTIONS:

1. Which soil had the slowest rate of permeability? ____________
2. Which soil had the fastest rate of permeability? ____________
3. Why did bubbles rise through the water as it was poured into the chimneys? ____________
4. When you put the dry soil into the cans or chimneys, the soil was at what stage of moisture? field capacity, saturation, wilting point (*Circle one*)
5. When there was water still at the top of the can and water was also dripping from the bottom of the can, the soil was at what stage of moisture? field capacity, saturation, wilting point (*Circle one*)
6. When the water had stopped dripping from the bottom of the can or chimney, the soil was at what stage of moisture? field capacity, saturation, wilting point (*Circle one*)

INTERPRETATION:

The soil which had the slowest rate of permeability actually had more and smaller pore spaces between soil particles. Therefore, it took longer for these smaller pores to become filled with water. The soil which had the fastest rate of permeability had fewer but larger pore spaces to be filled with water; consequently, the water moved through faster. So much for texture!

Now what do you think would happen if this same experiment were tried with some soils still in place, their structure undisturbed? What if both were silty clays, one with a blocky structure and one with a platy structure? Which would have the slower rate of permeability? If you refer to page 22 in the student manual, showing the various soil structures, you can see that water would be able to move downward faster through the blocky structure than through the platy structure. There are more spaces in the blocky structure for water to move through.

We will be referring to permeability of soils again in the next section. Before going on, ask your instructor any questions you now have concerning the basic principles of permeability.

EVALUATION:

1. The exercise was completed as directed. ____________
2. The chart (above) was completed neatly and accurately. ____________
3. The questions were answered correctly. ____________
4. Materials and equipment were properly cleaned and stored. ____________

FINAL GRADE ________

NAME ____________

STUDENT EXERCISE 2-F

THE LITMUS PAPER TEST ON SOIL

The objective of this exercise is to determine the acidity or alkalinity of a soil sample solution with litmus paper.

MATERIALS:

- several soil samples
- test tube for each sample
- distilled water
- litmus paper or pH reagents

PROCEDURE:

1. Place 1 inch of soil in a test tube and mix with water.
2. Allow the mixture to settle.
3. Touch one end of a strip of litmus paper to the soil solution. Note any color change.

INTERPRETATION:

If the litmus paper turns red in the solution, the solution is acid. If the litmus paper turns blue, the solution is alkaline.

EVALUATION:

1. The exercise was completed as directed. ____________
2. All materials and equipment were cleaned and stored properly. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 2-G

USING *INVENTORY OF OHIO SOILS*

In this exercise you can learn how to make use of the *Inventory of Ohio Soils* in your own area.

MATERIAL:

- *Inventory of Ohio Soils*

PROCEDURE:

1. On the General Soils Map of your county, locate the general soil types found in the nursery where you work. (If your teacher has obtained a soils map of your area, use this map to find the specific soil types found in the nursery where you work.)
2. From the information describing each soil in the booklet, fill in the blanks with the correct information for one of the soils found in the nursery.

1. Soil number ______________________
2. Soil type ______________________
3. Soil color ______________________
4. Drainage class ______________________
5. Parent material ______________________
6. Slope descriptions ______________________
7. Characteristics of typical cultivated soil:

a. __________ inches ______________________

____

b. __________ inches ______________________

____

c. __________ inches ______________________

From the information on Table 3 in the packet, continue filling in the blanks with the correct information for the same soil.

8. Depth from surface (typical profile inches). (Use only the first number to represent the A horizon in the profile.)

____

9. USDA Texture ______________________
10. Range in permeability (inches per hour) __________ to __________
11. Average permeability (From the blanks in #10, add the two numbers and divide this number by 2.)

____

12. Range in Available Moisture Capacity (inches per inch of depth)

__________ ______________________

(continued)

Student Exercise 2-G *(continued)*

13. If the A horizon had reached the wilting point for available moisture and we wanted to irrigate a certain field of this type of soil to bring the A horizon to its available moisture capacity, how many inches of water would we need to add?

    ____

    (*Hint* - Find the average for #12. Multiply this answer by the answer you put in #8.)

14. Reaction pH ________________________________

15. Is this soil acidic or basic (alkaline)? ________________________

EVALUATION:

1. Sites were correctly located on the soil map. ____________

2. Blanks were filled in with correct information. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 2-H

LEARNING ABOUT MULCHES

The purpose of this exercise is to familiarize students with the types of mulches used and the reasons for using them.

PROCEDURE:

1. During the next few days make note of the various types of ground coverings found in several nurseries. Observe the greenhouse, coldframes, fields, containers and gardens around the nursery or houses on the nursery property.
2. In the space provided below, give the requested information pertaining to mulches used at the sites you visited.

TYPE OF MULCH	WHERE IT IS USED	REASON FOR USING THIS MULCH

EVALUATION:

The chart was completed as directed. ______________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 2-I

EFFECT OF RAINDROP SPLASH

The objective of this exercise is to determine the effect of raindrop splash on soils.

MATERIALS:

- soil sample
- eye dropper or bulb pipette
- stiff white paper
- pan to hold soil sample
- yardstick
- tape

PROCEDURE:

1. Place soil sample in pan to a depth of ¾ - 1 inch.
2. Hold the stiff white paper to the pan with tape, as shown in Figure 2-6.
3. Hold the eye dropper at different heights above the soil, first measuring each time the height of the eye dropper, then releasing the water in the eye dropper a drop at a time. Observe the white paper after each drop of water hits the soil.

INTERPRETATION:

The impact of a raindrop falling on bare soil is the greatest cause of water erosion. The force of the raindrop hitting the bare soil breaks loose some of the particles from the aggregates and causes them to be washed away. (You will see some of these particles splashed onto the white paper.) In some parts of the country (not in Ohio) wind erosion is of more concern than water erosion.

What can the agriculturist (in our case, the nursery operator) do to protect the soil available and thus practice soil conservation? Actually, the conservation practice that adds organic matter to the soil also protects the soil by providing a cover to prevent erosion. More and more nursery operators are practicing forms of soil conservation to protect the valuable land from which they make their living.

EVALUATION:

1. The exercise was completed as directed. ______________
2. All equipment and materials were cleaned and put away. ______________

FINAL GRADE ________

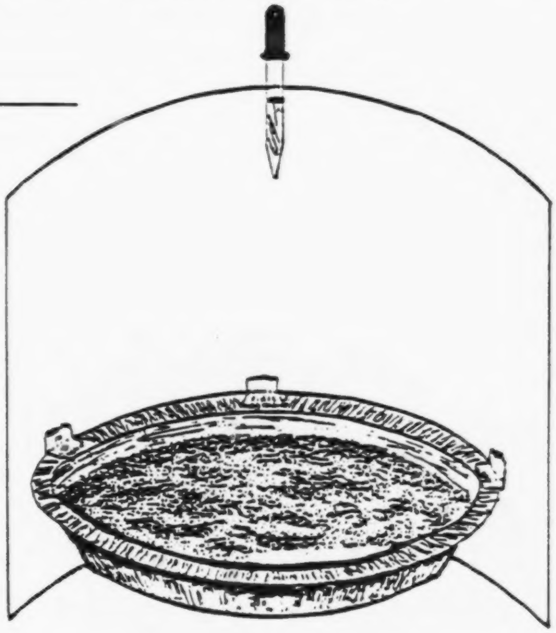


Figure 2-6. Soil sample in a pan, ready for splash test.

NAME ______________________

QUIZ - CHAPTER 2

TRUE OR FALSE

Read each statement correctly. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. Soil is a natural mixture of weathered minerals and decaying organic materials.

T F 2. Erosion can be a serious problem because it removes primarily the productive topsoil.

T F 3. The type of vegetation in an area can influence the type of soil which develops.

T F 4. Field capacity is the point at which all pores in the soil capable of holding moisture against the pull of gravity are completely filled with water.

T F 5. Over-cultivation reduces organic matter content.

T F 6. Organic matter destroys soil tilth.

T F 7. Soil pH can affect nutrient availability.

T F 8. Plants must have a pH of 7 to grow properly.

T F 9. Most plants get all of their oxygen from water.

T F 10. Drainage is the removal of all soil water.

T F 11. Surface drainage carries off water before the soil becomes saturated.

T F 12. Loam is always ideal soil for growing nursery stock.

T F 13. Mulch is used primarily to add organic matter to soil.

T F 14. Organic matter and air make up about equal proportions of the soil.

T F 15. Sand particles are larger than silt particles.

T F 16. A soil with a pH above 7.0 is said to be alkaline.

T F 17. You can make a soil more alkaline, but you cannot make it more acidic.

MULTIPLE CHOICE

Read each item and decide which choice correctly completes the statement or answers the question. Circle the letter of your choice.

18. Which of the following would probably **not** help break down rocks into soil?

A. insects
B. rain
C. wind
D. frost & ice

19. Which of the following types of rocks was formed from molten or melted material from volcanoes?

A. igneous rocks
B. sedimentary rocks
C. metamorphic rocks
D. all of the above

20. Topography refers to . . .

A. the time it takes for soils to develop
B. the type of vegetation in a given area
C. the lay of the land
D. the type of rocks in a given area

(continued)

QUIZ - page 2

21. How much of the soil is typically made up of mineral matter?

    A. 5 percent
    B. 20 percent
    C. 45 percent
    D. 95 percent

22. At optimum moisture capacity water makes up about ________ percent of a soil.

    A. 5
    B. 25
    C. 50
    D. 85

23. Which of the following types of water is unavailable for plant use?

    A. hygroscopic water
    B. capillary water
    C. gravitational water
    D. rain water

24. Which of the following soil structures permits rapid penetration of water?

    A. platy
    B. crumb
    C. massive
    D. columnar

25. A neutral soil has a pH of . . .

    A. 3
    B. 5
    C. 7
    D. 9

26. pH is a measure of soil . . .

    A. porosity
    B. acidity or alkalinity
    C. granulation
    D. fertility

27. Which of the following materials can be used to raise the pH of a soil?

    A. iron sulfate
    B. aluminum sulfate
    C. limestone
    D. peat moss

28. Which of the following materials can be used to lower the pH of a soil?

    A. aluminum sulfate
    B. limestone
    C. dolomite
    D. nitrogen

29. Killing **all** organisms in the soil is . . .

    A. sterilization
    B. pasteurization
    C. irrigation
    D. vernalization

30. Soil pasteurization has been accomplished when the coldest point in the soil has been heated to ________ degrees F for 30 minutes.

    A. 120
    B. 150
    C. 180
    D. 212

31. Which of the following pests can be killed by fumigation?

    A. nematodes
    B. fungi
    C. bacteria
    D. all of the above

32. Perlite is . . .

    A. expanded volcanic rock
    B. expanded silica sand
    C. expanded mica
    D. expanded bone meal

33. Vermiculite is . . .

    A. expanded volcanic rock
    B. expanded mica
    C. expanded silica sand
    D. expanded bone meal

(continued)

QUIZ - page 3

34 The term for crops that are plowed under to build up the organic matter content of the soil is . .

A. mulch
B. green manure crop
C. cover crop
D. peat

MATCHING

Select a definition from Column B which matches each term in Column A. Fill in each blank with the correct letter.

Column A

_____ 35. solum
_____ 36. parent material
_____ 37. topsoil
_____ 38. subsoil
_____ 39. humus
_____ 40. tilth
_____ 41. saturation point
_____ 42. soil texture
_____ 43. loam
_____ 44. soil structure
_____ 45. aggregate
_____ 46. mottled
_____ 47. topography
_____ 48. parent material

Column B

A. a group of soil particles
B. **A** horizon
C. **B** horizon
D. **C** horizon
E. both **B** and **C** horizons
F. both **A** and **B** horizons
G. soil particle size
H. grouping of soil particles
I. having variegated colors
J. mixture of sand, silt, & clay
K. decomposed organic matter
L. the point at which soil cannot hold any more moisture
M. the desirable, workable condition of soil
N. rocks which break down to form soil
O. the lay of the land
P. a combination of natural events such as rain, temperature, etc. that contribute to the formation of soils

ANSWER KEY - CHAPTER 2

Key Questions, Part 1 - page 2-3

SOIL FORMATION

1. Nursery operators must be aware of the increasing value of land and must take steps to use the land in the most effective way possible.
2. Soil is the relatively thin layer covering the earth. It is a natural mixture of weathered minerals and decaying organic materials.
3. Soils are formed by the weathering of rocks.
4. Parent material, climate, plants and animals, topography, time.
5. Igneous rocks, sedimentary rocks, metamorphic rocks
6. Glaciers left behind rocks and dirt scraped from other areas. Glaciers account for more variety of parent material than does any other factor.
7. Extremes of temperature and precipitation can affect the speed of weathering.
8. Plants and animals add organic matter to the soil.
9. Topography is the "lay of the land."
10. Topography influences soil movement, soil depth, and internal soil drainage.
11. It takes time for the forces of climate to break down parent material or to move parent material to a new location. It also takes time for plants and animals to develop and eventually die and decay.
12. After soils have been formed, time influences the depth of the soil profile and the extent to which soils have been weathered.
13. Leaching is the washing out of soluble minerals from the soil due to heavy rainfall or heavy irrigation.

Key Questions, Part 2 - page 2-5

SOIL PROFILES

1. A soil profile is a diagram of the vertical section of a soil showing the thickness and character of the various soil horizons.
2. A horizon = topsoil

   B horizon = subsoil

   C horizon = parent material
3. Topsoil is the uppermost soil horizon — the productive (fertile) portion of the soil.
4. Subsoil is the soil below the usual depth of cultivation, containing little or no humus.
5. The solum is a combination of the A and B horizons. In the solum most plant root growth takes place.

SOIL COMPONENTS

6. Humus is the substance left after organic matter has decayed.
7. (1) Organic matter is responsible for the desirable working condition of soils.

   (2) It results in increased soil aeration.

   (3) It supports the many microorganisms found in the soil.

Answers *(continued)*

SOIL WATER

8. *Hygroscopic water* is held so tightly to soil particles that plants cannot use it. *Capillary-water* is held more tightly than the pull of gravity, but weakly enough to be used by plants. *Gravitational water* is more attracted to the pull of gravity than to the soil particle. It drains down through the soil.
9. When a soil has reached the saturation point, it cannot hold any more water.
10. Field capacity is the amount of water that soil can hold after draining off excess gravitational water.

Key Questions, Part 3 - page 2-7

SOIL TEXTURE

1. Soil texture refers to the size of the soil particles.
2. Loam is a soil composed of equal parts of sand, silt and clay.

SOIL STRUCTURE

3. Soil structure refers to the grouping of individual soil particles.
4. An aggregate is a group of soil particles.

SOIL TYPES

5. Crumb, single grain, columnar, granular, massive, blocky, prismatic, platy.
6. Tilth is the desirable working condition of soils.
7. Tilth can be improved by increasing the organic matter content of soils.

SOIL ACIDITY AND ALKALINITY

8. pH is a symbol used to express the acidity and alkalinity of soil.
9. A neutral soil is neither acid or alkaline. It has an equal number of H+ and OH- ions. Neutral soil has a pH of 7
10. pH can influence how readily plants absorb nutrients from the soil.
11. Soil acidity can be reduced by adding some form of lime.
12. Burned lime, hydrated lime, carbonate of lime, agricultural pulverized limestone, agricultural slag.
13. Soils can be made less alkaline by adding sulfur or aluminum sulfate.

Key Questions, Part 4 - page 2-9

DRAINAGE

1. With too much water in soils, plant roots may not have adequate oxygen. This can kill plants or cause poor plant growth.
2. Drainage is the movement of excess water through the soil.
3. Sterilization is the killing of all organisms in the soil. Pasteurization kills some, but not all, organisms.
4. Fumigation is the sterilization of soil by chemicals.
5. Soil is pasteurized by heating it to 180° for 30 minutes.
6. Steaming soil can result in a build-up of ammonia in the soil. Ammonia can burn the roots of young plants.
7. When all nitrifying bacteria in the soil are killed, there is a build-up of ammonia in the soil.

Answers *(continued)*

Key Questions, Part 5 - page 2-10

SOIL MIXES

1. An ideal soil mix (1) has good structure that provides good aeration and holds adequate moisture; (2) provides adequate available nutrients for the plant to grow properly; (3) does not contain harmful organisms or toxic materials; (4) is light in weight but rigid enough to support plants.
2. Bulk density is the weight of the soil.
3. The cation exchange capacity of a soil is important to plant growth because it influences the availability of plant nutrients.
4. Hardwood bark (1) has coarse particles that resist compaction; (2) has fair water-holding capacity; (3) has good drainage; (4) has good nutrient-holding capacity.
5. Peat has high water-holding capacity, contains some nitrogen, provides good aeration, does not tie up nutrients, and is light in weight.
6. Perlite is light, does not cake-up with continued use, and provides for good aeration.
7. Vermiculite is light, has a neutral reaction, and is insoluble in water.

Key Questions, Part 6 - page 2-11

MULCH

1. Mulch is used to cover or dress the soil around plants.
2. (1) Insulates soil and helps regulate soil temperatures.

   (2) Conserves moisture and prevents rapid evaporation.

   (3) Prevents erosion.

   (4) Prevents build-up of weeds.

   (5) Prevents packing of soil.

   (6) May serve as a source of organic matter.
3. Soil can be renewed by conservation practices and by adding organic matter by means of green manure crops.
4. A green manure crop is a crop which is plowed under to add organic matter to the soil.
5. A cover crop is planted to protect bare soil from erosion. It can also be used to add organic matter to the soil.
6. A soil-building crop is used to help maintain soil tilth and prevent loss of soil.

Terms to Remember, Part 1 - page 2-12

1. mulch
2. solum
3. bulk density
4. vermiculite
5. aggregate
6. parent material
7. hygroscopic water
8. sedimentary rock
9. agronomy
10. capillary water
11. subsoil
12. metamorphic rock
13. soil-building crop
14. topsoil
15. mottled
16. cover crop
17. topography
18. pasteurization
19. loam

Terms to Remember, Part 2 - page 2-14

1. tile drainage
2. sterilization
3. erosion
4. gravitational water
5. peat
6. leaching
7. soil texture
8. fumigation
9. perlite
10. field capacity
11. pH
12. green manure crop
13. soil
14. saturation point
15. igneous rock
16. horizon
17. infiltration
18. soil profile
19. soil structure

Answers *(continued)*

Crossword Puzzle 2A - page 2-17

ACROSS

3. sedimentary
5. tile
6. pasteurization
10. solum
11. parent
13. agronomy
17. metamorphic
20. topography
21. top
22. erosion
23. loam
24. infiltration

DOWN

1. vermiculite
2. peat
4. perlite
7. sterilization
8. leach
9. saturation
12. aggregate
14. fumigation
15. hygroscopic
16. cover
18. igneous
19. pH

Crossword Puzzle 2B - page 2-19

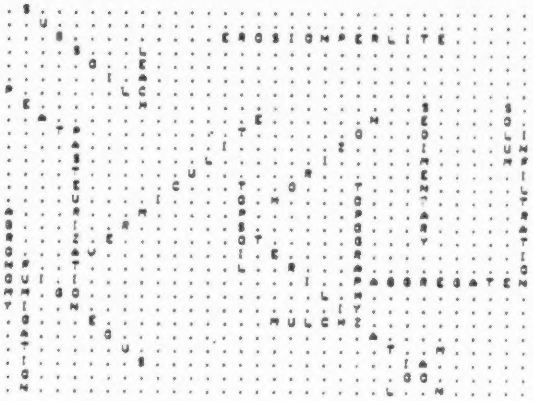
ACROSS

1. pasteurization
5. capillary
6. agronomy
7. sub
8. leach
11. igneous
13. topography
14. sedimentary
17. horizon
18. solum
19. pH
21. texture
22. loam
23. manure
24. mottled

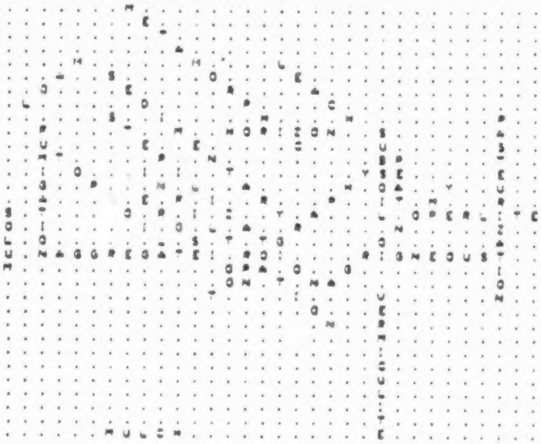
DOWN

2. sterilization
3. hygroscopic
4. cover
6. aggregate
7. soil
9. metamorphic
10. fumigation
12. vermiculite
14. structure
15. top
16. erosion
19. parent
20. peat

Letter Maze 2A - page 2-20



Letter Maze 2B - page 2-21



QUIZ

True or False - page 2-38

1. true
2. true
3. true
4. true
5. true
6. false
7. true
8. false
9. false
10. false
11. true
12. false
13. false
14. false
15. true
16. true
17. false

Multiple Choice - page 2-38

18. A
19. A
20. C
21. C
22. B
23. A
24. B
25. C
26. B
27. C
28. A
29. A
30. C
31. D
32. A
33. B
34. B

Matching - page 2-40

35. F
36. D
37. B
38. C
39. K
40. M
41. L
42. G
43. J
44. H
45. A
46. I
47. O
48. N
49. P

GLOSSARY - Chapter 2

aggregate - a group of soil particles.

agronomy - the science of soil management and the production of field crops.

bulk density - the weight of soil.

capillary water - water that is available to plants. This water is held more tightly to the soil particle than the pull of gravity, but held weakly enough to allow the water to be used by plants.

cover crop - a herbaceous crop sown to cover the ground temporarily. It protects the ground from erosion. Generally the crop is plowed under for its organic value.

erosion - the process of wearing away rocks and soil by natural agents.

field capacity - the amount of water the soil can hold after draining off excess gravitational water.

fumigant - a chemical used to kill insects, nematodes, fungi, bacteria, seeds, roots, rhizomes, or entire plants. Typically used within the soil.

gravitational water - water that is free to move through soil under the influence of gravity.

green manure crop - a cover crop which is plowed under while still green to improve the soil.

horizon - a layer of soil which differs in composition and/or structure from adjacent layers.

hygroscopic water - water or moisture strongly attached to soil particles, not available to plants.

igneous rock - rock produced under intense heat, such as rocks of volcanic origin.

infiltration - filtering into or permeating through the soil.

leaching - washing out of soluble materials from the soil.

loam - a soil containing relatively equal amounts of sand, silt, and clay.

metamorphic rock - rock formed through a process of change caused by pressure or heat.

mottled - spotted or blotched in coloring.

mulch - a loose dry material used as a protective covering over the soil.

parent material - also known as the C horizon, this is the layer below the solum.

pasteurization - exposing soil to a high temperature in order to destroy certain microorganisms.

peat - partially decomposed sphagnum moss, a good water-holding medium.

perlite - a light-weight, granular material made out of a volcanic mineral. It is treated by heat and water so that it expands like popcorn. Used as or in a growing medium.

pH - a scale used to measure degrees of acidity and alkalinity, with 7.0 as the neutral point.

sanitation (of soil) - treatment of soil by heat, steam, or fumigation to eliminate harmful organisms and weed seeds.

saturation point - the point at which a soil cannot hold any more moisture.

sedimentary rock - rock formed by sediment deposits.

soil - a natural layer of the earth's surface in which plants grow. Composed of mineral and organic materials.

soil-building crop - a crop which helps to maintain the tilth and prevent losses of soil.

soil profile - a diagram of the vertical section of a soil showing the thickness and character of the various soil horizons.

soil structure - the arrangement of the mineral particles in the soil.

soil texture - the size of soil particles and the proportion of sand, silt, and clay in a soil.

solum - the combination of A and B horizons in the soil; the site of most plant root growth.

sterilization - the process of making a soil free of **all** harmful organisms, by heat, steam, or fumigation.

subsoil - soil below the usual depth of cultivation, containing little or no humus. Generally more dense than topsoil.

tile drainage - the internal drainage of a soil by the use of buried concrete, clay, or plastic tiles.

top soil - 1) a fertile soil or soil material rich in organic matter; 2) surface soil; 3) the original dark-colored upper soil ranging from a fraction of an inch to many feet in depth.

topography - the lay of the land.

vermiculite - a lightweight, expanded mica product often used as a rooting medium for plants or as a soil amendment.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 2

T2-1 *(Student Manual*, pages 11-14)

Basically, soils come from rocks. Nature acts upon rocks in several different ways, causing them to break down into smaller and smaller pieces until they eventually form soil. These are some of the factors responsible for soil formation.

Questions: How does parent material influence soil formation? How does climate affect soil formation? How do plants and animals, topography, and time affect soil formation?

T2-2 *(Student Manual*, page 12)

At one time two-thirds of Ohio and many other parts of the United States were covered by glaciers.

Question: What effect did glaciers have on the formation of soils?

T2-3 *(Student Manual*, page 12)

This illustration shows the accumulation of debris at the end of a glacial moraine.

Question: What effect did such debris have upon soil formation?

T2-4 *(Student Manual*, pages 14-15)

It takes time for parent material to develop into a mature soil. First the parent material must weather. Then various forms of plant life must grow and eventually die and decay.

Questions: Under ideal conditions, how long does it take for a mature soil to develop? If conditions are **not** ideal, how long can it take?

T2-5 *(Student Manual*, pages 15-16)

Certain characteristics cause the different layers of soil to be very noticeable. These layers (horizons) often differ in color, texture and structure.

Questions: Why is the **A** horizon important to nursery operators? Where does most root growth take place?

T2-6 *(Student Manual*, pages 16-17)

Soil is made up of mineral material, organic matter, air, and water.

Questions: Where does the organic matter in soils come from? Why is organic matter important?

T2-7 *(Student Manual*, pages 16-17)

Minerals make up about 45% of a typical soil. Air and water account for another 50%. Organic matter usually comprises about 1 to 5% of a soil.

Question: How does the amount of water in a soil affect the amount of air in that same soil?

T2-8 *(Student Manual*, page 17)

Air in soils is located in the soil pore spaces. Because the particles of soil vary in size, so do the pore spaces.

Questions: At optimum moisture conditions, what percentage of these pore spaces is occupied by water? By air?

……

T2-9 *(Student Manual*, pages 17-18)

There are three classifications of soil water. **Hygroscopic water** (A) is held so tightly by the soil particle that it is unavailable for plant use. **Capillary water** (B) is held by the soil particle against the pull of gravity, but it is held weakly enough to be used by plants. **Gravitational water** (C) is pulled through the soil by gravity. Soil particles cannot hold any gravitational water.

……

T2-10 *(Student Manual*, page 18)

A soil at saturation point is so full of water that it cannot hold any more.

Questions: What happens to pore spaces in a saturated soil? What happens to plant roots in a saturated soil?

……

T2-11 *(Student Manual*, page 18)

"Field Capacity" is the stage at which all spaces in the soil which are capable of holding water against the pull of gravity are completely filled with water. At this stage, gravitational water has moved down through the soil into another horizon.

Question: What is the difference between a saturated soil and a soil at field capacity?

……

T2-12 *(Student Manual*, pages 18-19)

A soil at the wilting point contains very little water.

Question: Why do plants wilt when there is still some hygroscopic water attached to the soil particles?

……

T2-13 *(Student Manual*, pages 19-20)

The size of soil particles (soil texture) is important to the study of soils, and to the relationship of plants to various soils. The amount of space between particles has a lot to do with the ease of water movement through soil and the water-holding capacity of soil.

Questions: How quickly do you think water would enter a soil composed primarily of clay particles? Why? How quickly would water enter a very sandy soil? Why?

……

T2-14 *(Student Manual*, pages 25-26)

The term "pH" refers to whether a substance is alkaline or acidic. On this scale 7 is the neutral point — neither acidic nor alkaline.

Question: Why is soil pH important to nursery operators?

……

T2-15 *(Student Manual*, pages 25-26)

In a neutral soil hydrogen and hydroxyl ions are found in equal amounts. In an acidic soil there are more hydrogen ions. In an alkaline soil there are more hydroxyl ions.

T2-16 *(Student Manual*, pages 26-27)

The effect of an acid or alkaline soil on plants is more indirect than direct. In a soil which is too alkaline or too acidic there may not be enough nutrients available for good plant growth. This illustration shows the availability of several nutrients at various pH levels.

Questions: If a plant requires large amounts of available nitrogen, what pH level would you recommend? At what pH is manganese most readily available?

T2-17 *(Student Manual*, pages 29-31)

This is a comparison of poorly drained land with tile-drained land. Notice that the plant roots in the poorly drained soil have not made nearly as much growth as those in the tile-drained soil.

Question: Why do plants grow better in a tile-drained soil than in a poorly drained soil?

T2-18 *(Student Manual*, pages 30-31)

If drains are not spaced correctly in a field, some of the plants may remain too wet. These plants will not grow as well as those which are closer to the drains.

T2-19 *(Student Manual*, pages 32-33)

Several types of tile drainage systems are shown in this figure. Notice that 5-inch tile is used in wet areas that are to be drained. Eight-inch tile is used to carry off water that empties into the main channel from arms or branches of the entire system.

Question: Where could you obtain technical assistance when laying out and installing a tile drainage system?

T2-20 *(Student Manual*, pages 34-36)

One common problem that occurs after steaming is the buildup of ammonia in the soil. Before steaming, ammonifying bacteria take nitrogen in the raw form and change it into ammonia. Some nitrifying bacteria in the soil then take the ammonia and change it into nitrates which are used by plants.

When soil is steamed, the nitrifying bacteria are killed, but many of the ammonifying bacteria survive. These ammonifying bacteria keep working, so eventually there is a buildup of ammonia in the soil.

Questions: Why is a buildup of ammonia in the soil harmful to plants? How can such an ammonia buildup be prevented?

Factors Responsible for Soil Formation

Parent material

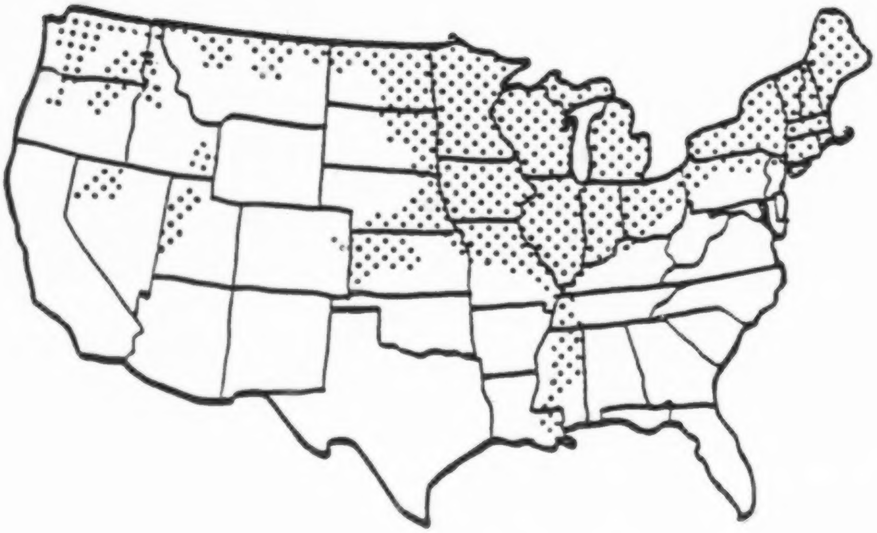
Climate

Plants and animals

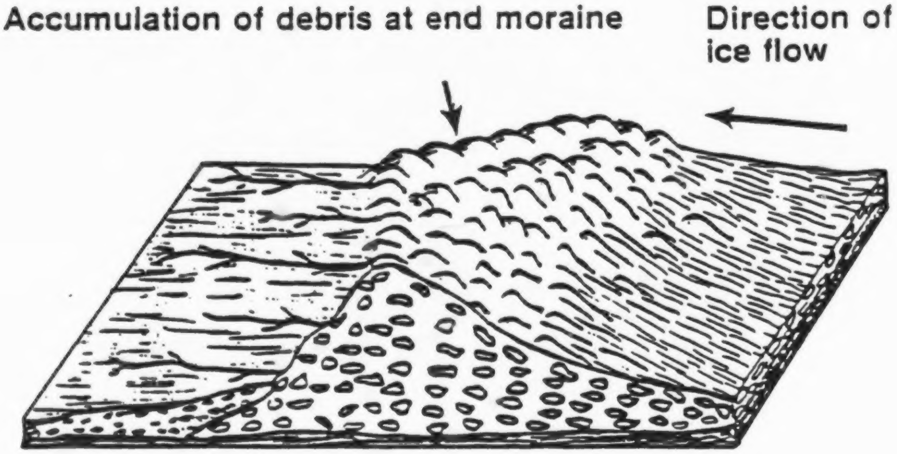
Topography

Time

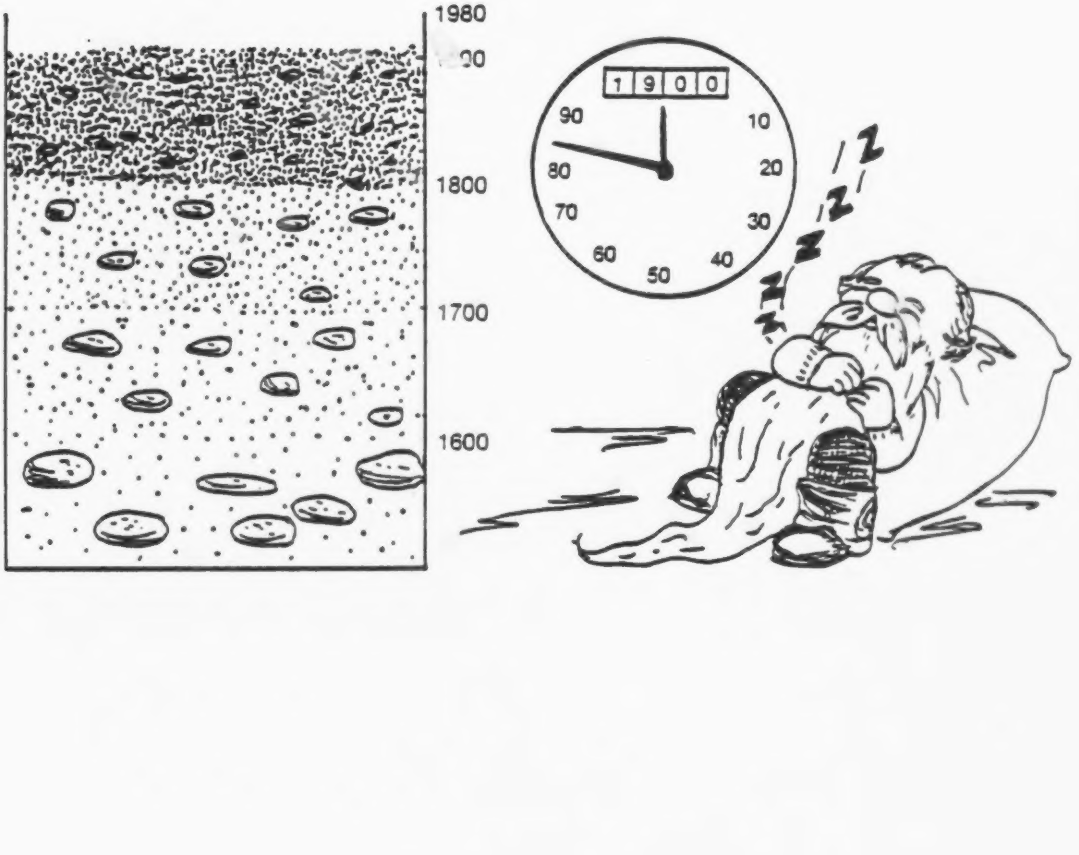
Areas of the United States Once Covered by Glaciers



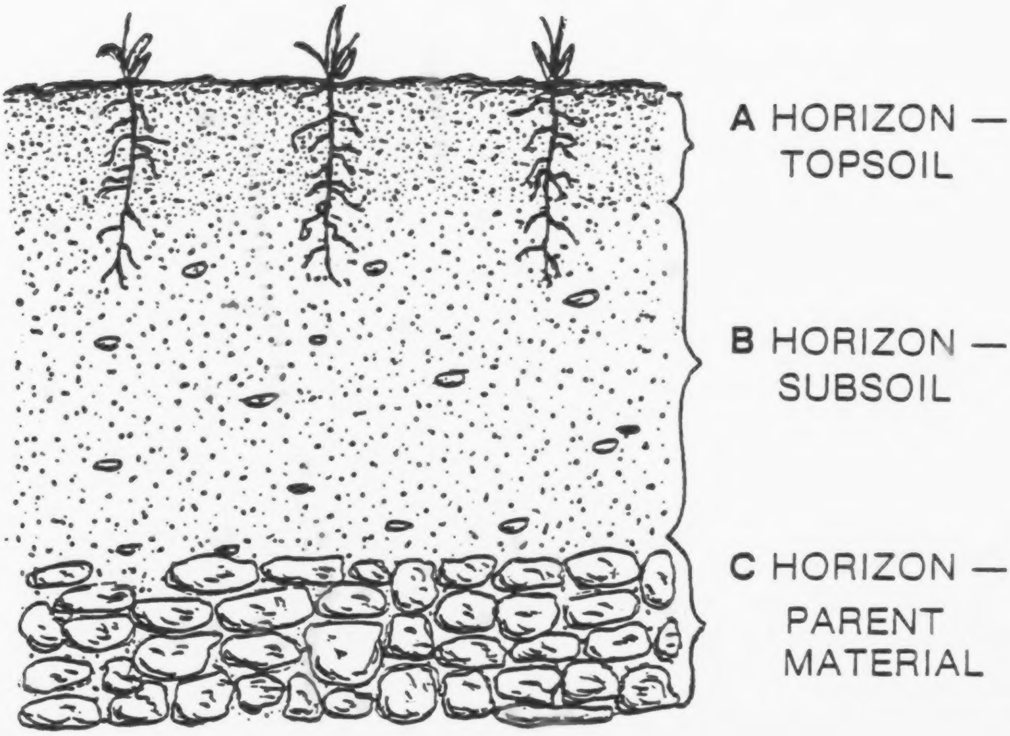
Aftereffects of Glaciers


Accumulation of debris at end moraine
Direction of ice flow

It takes many years for the forces of nature to develop a mature soil.


1980
00
1800
1700
1600
1900
90
10
80
20
70
30
60
40
50
Z
Z
Z
Z
Z

A Soil Profile


A HORIZON — TOPSOIL
B HORIZON — SUBSOIL
C HORIZON — PARENT MATERIAL

Components of Soil

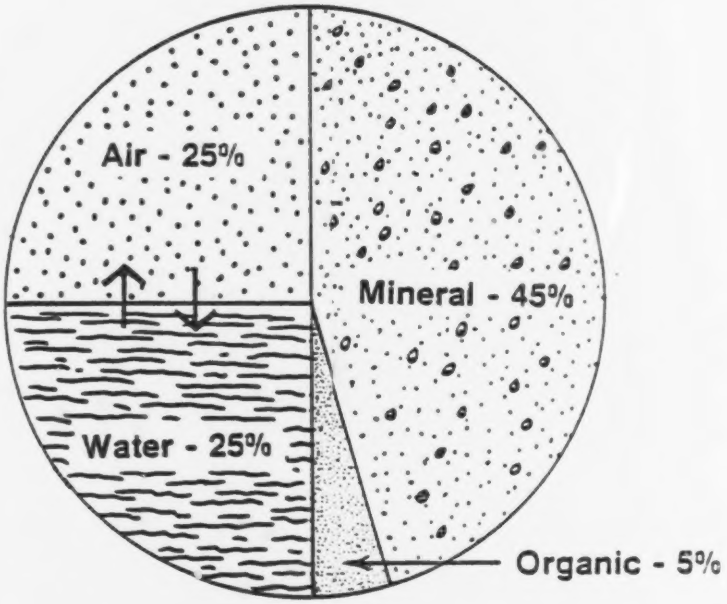
Mineral material

Organic matter

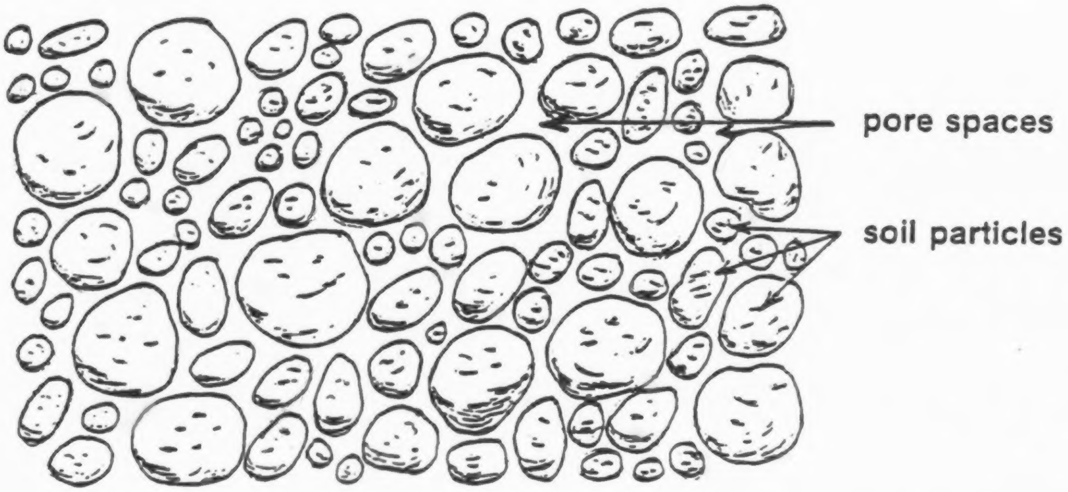
Air

Water

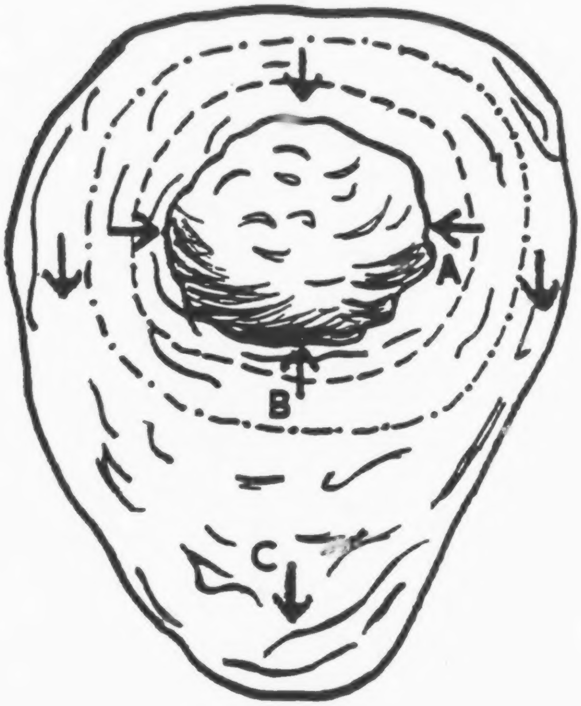
Components of the Soil and Their Percentages



Pore Spaces between the Soil Particles

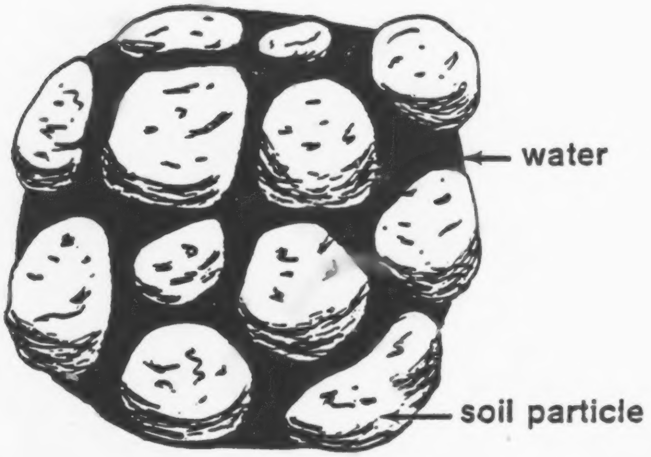

pore spaces
soil particles

Water-holding Forces of a Soil Particle

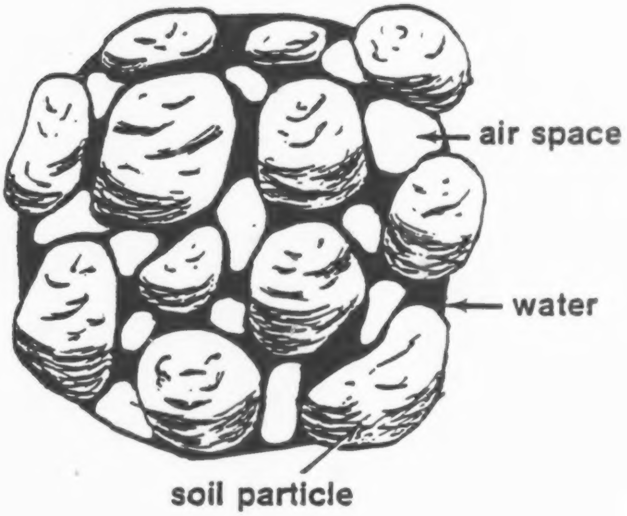


A. Hygroscopic water
B. Capillary water
C. Gravitational water

Soil at the Saturation Point

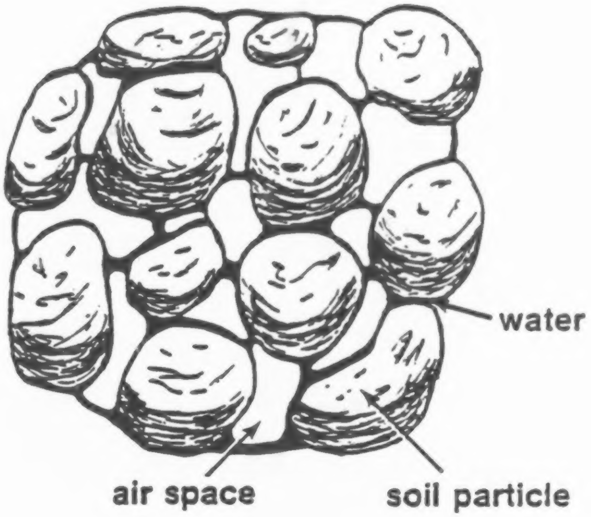

water
soil particle

Soil at Field Capacity

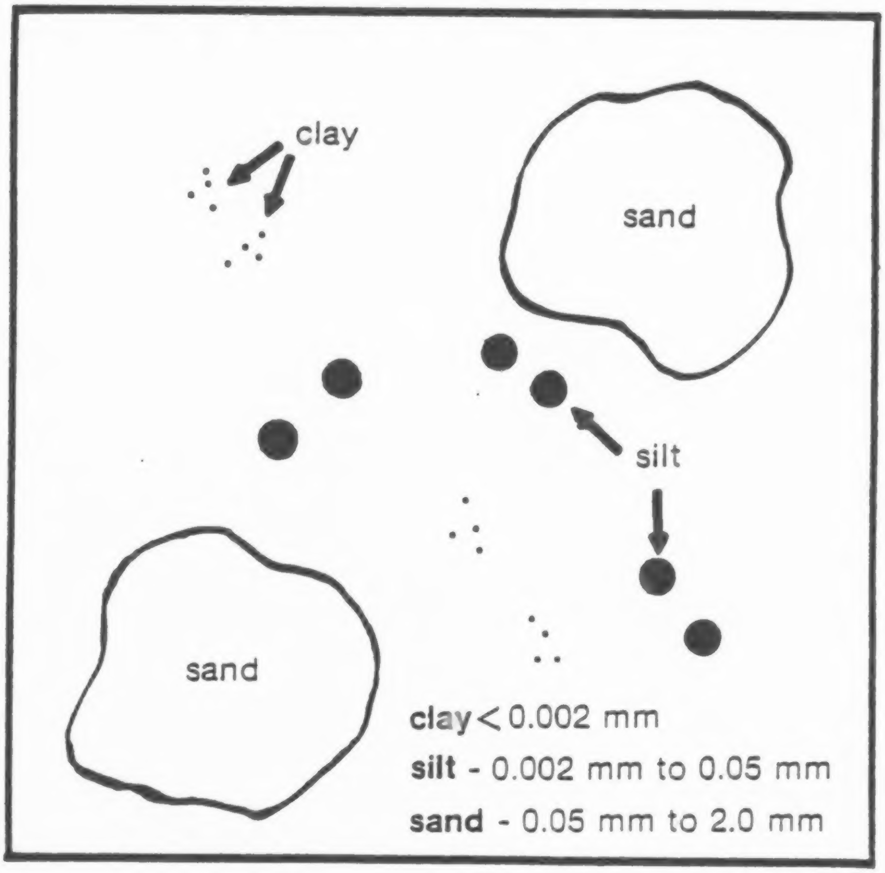

air space
water
soil particle

90

Soil at the Wilting Point

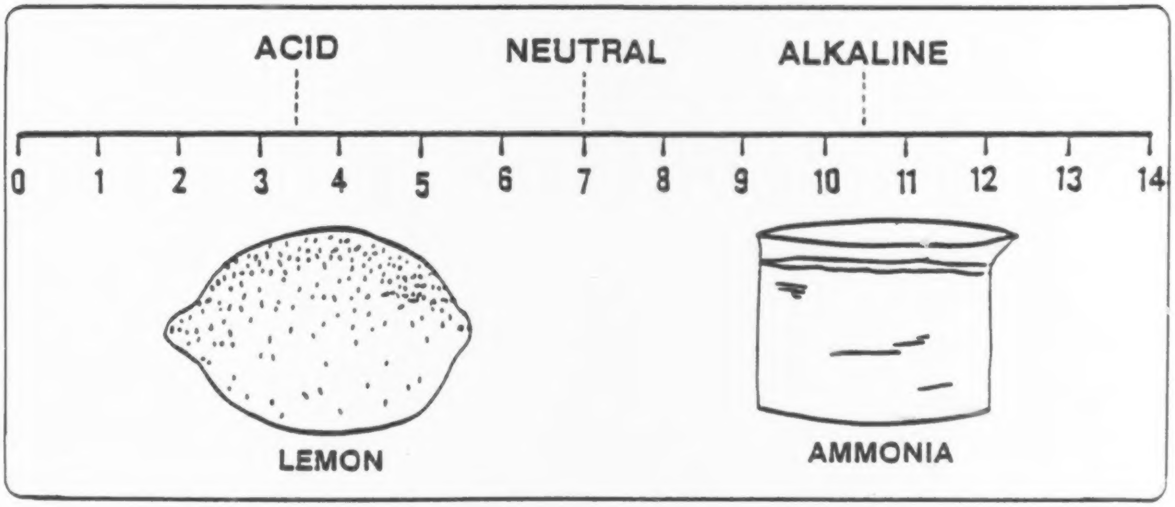

water
air space
soil particle

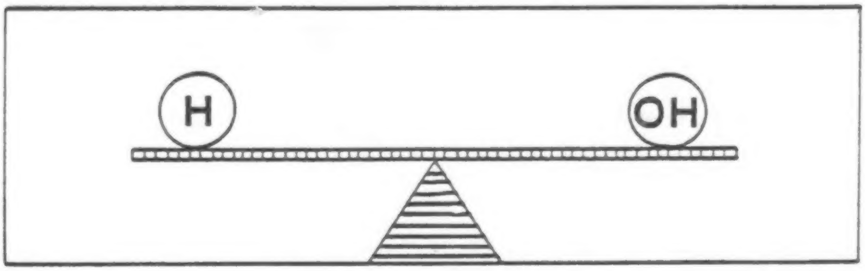
Relative Sizes of Sand, Silt, and Clay


clay
sand
silt
sand

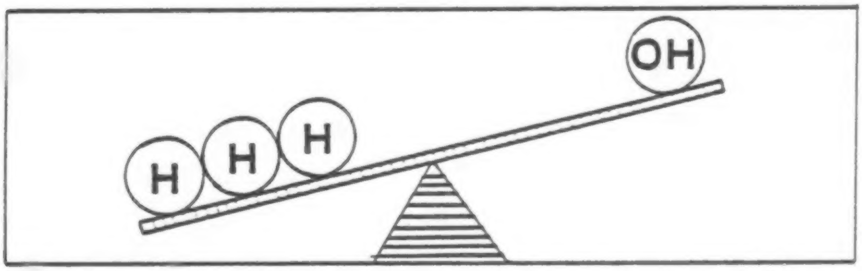
clay < 0.002 mm
silt - 0.002 mm to 0.05 mm
sand - 0.05 mm to 2.0 mm

The pH Scale

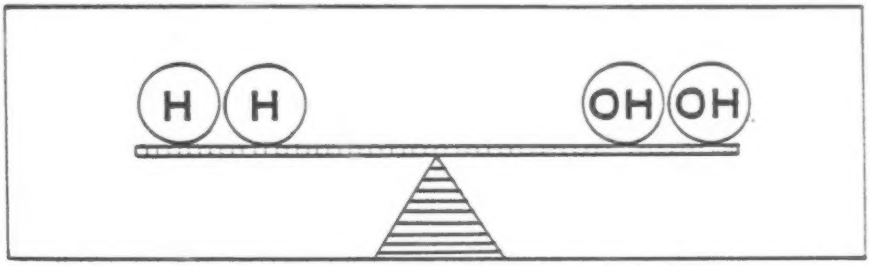

ACID
NEUTRAL
ALKALINE
LEMON
AMMONIA



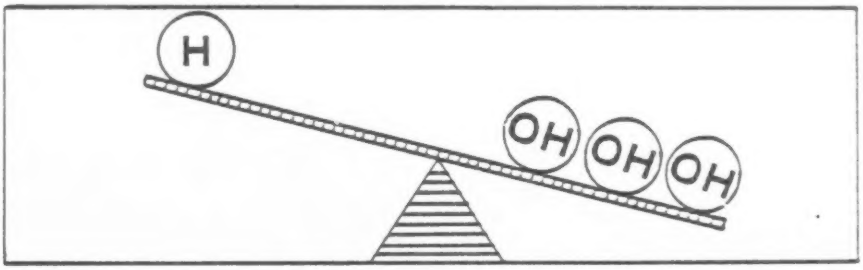
Relationship of hydrogen and hydroxyl ions in a neutral soil.



Relationship of hydrogen and hydroxyl ions in an acid soil.

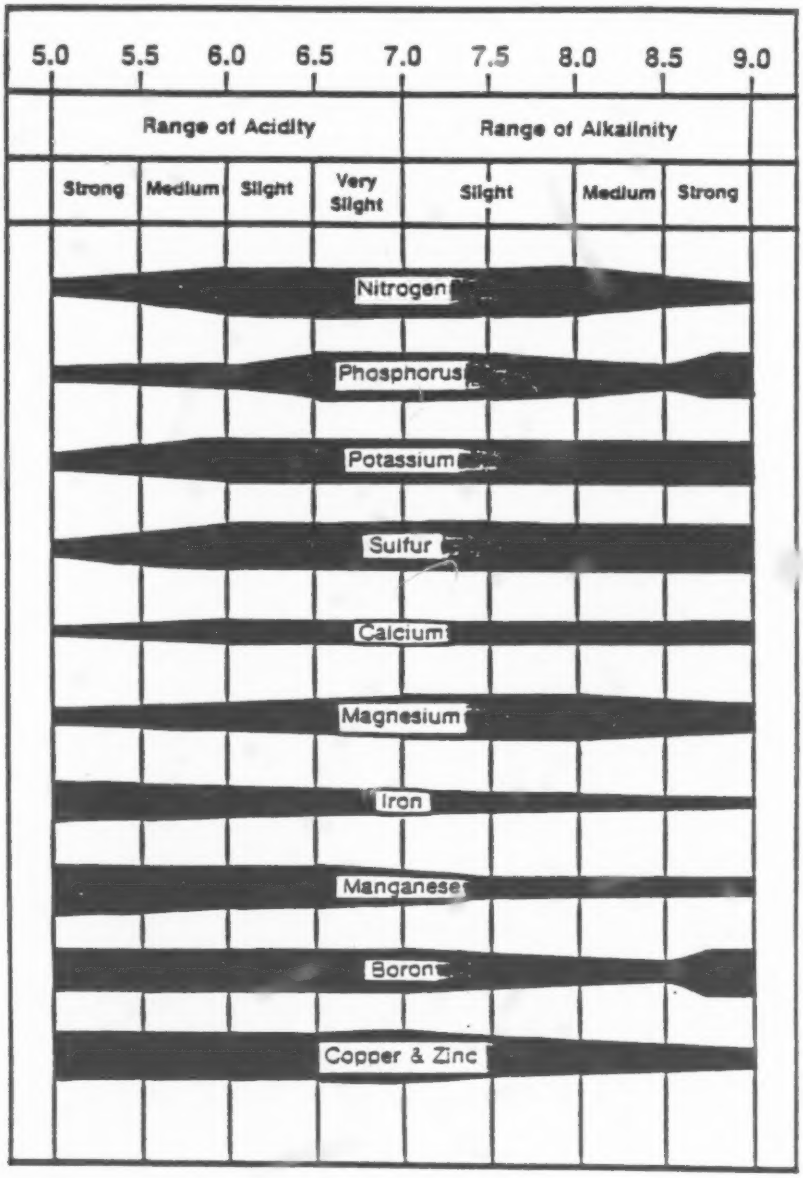


A solution that has been balanced (returned to neutral).

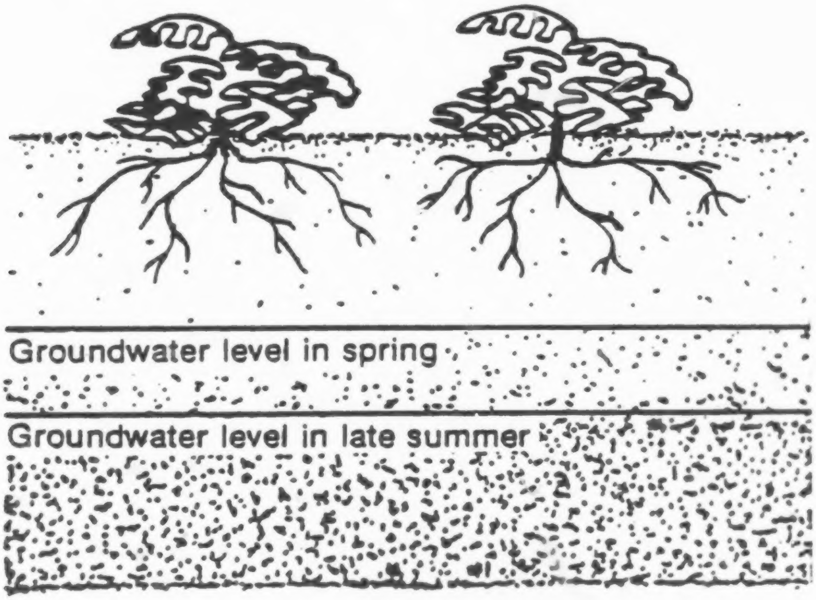


Relationship of hydrogen and hydroxyl ions in an alkaline soil.

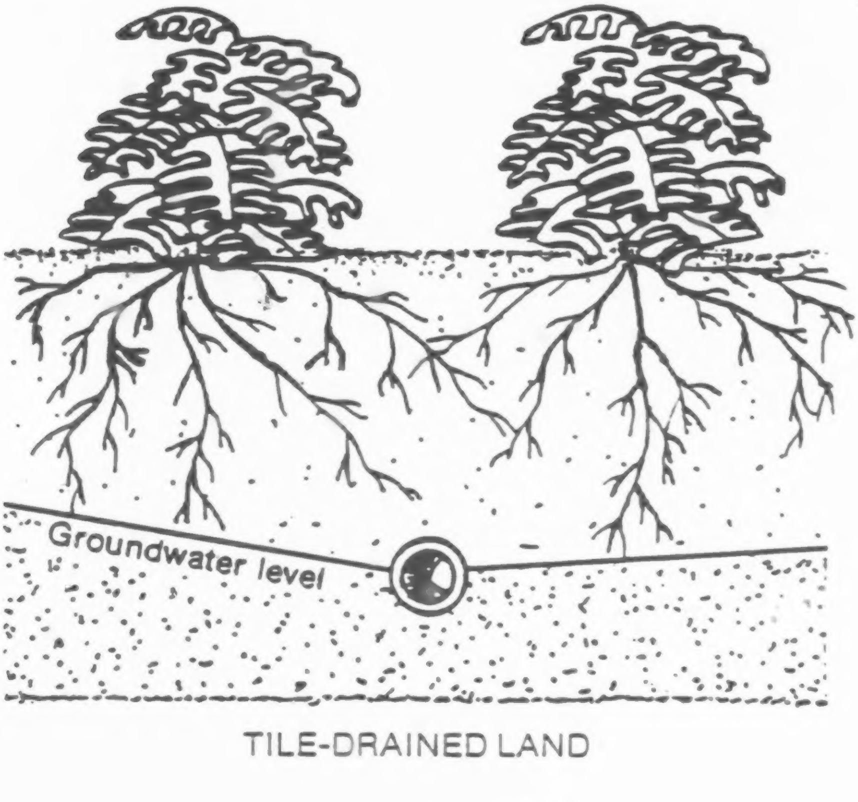
Availability of Plant Nutrients at Different pH Levels in Mineral Soils



Comparison of Poorly Drained and Tile-drained Land

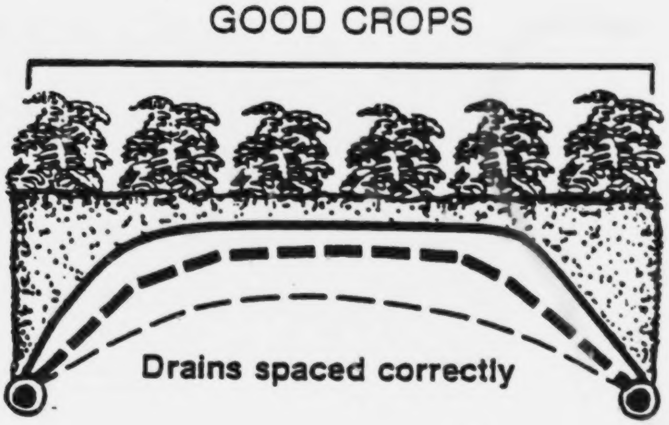

Groundwater level in spring
Groundwater level in late summer

POORLY DRAINED LAND


Groundwater level

TILE-DRAINED LAND

Spacing for Drains in a Field

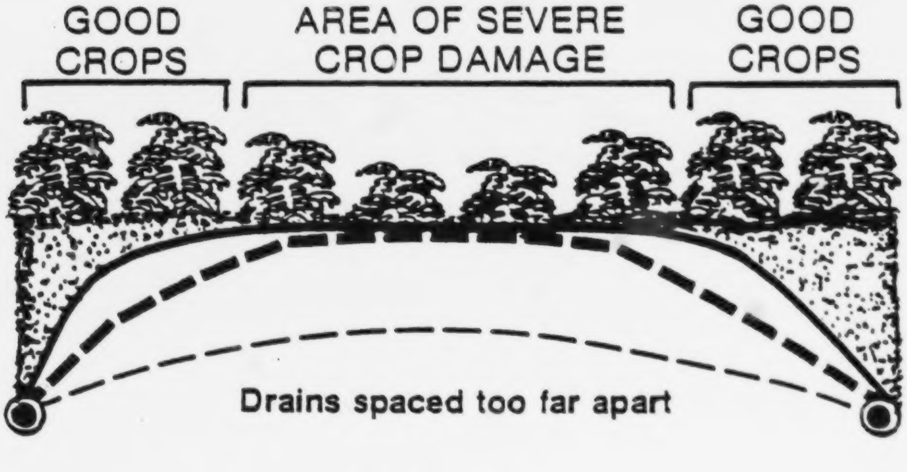


Drains spaced correctly

——— Groundwater level 24 hours after rain saturates soil

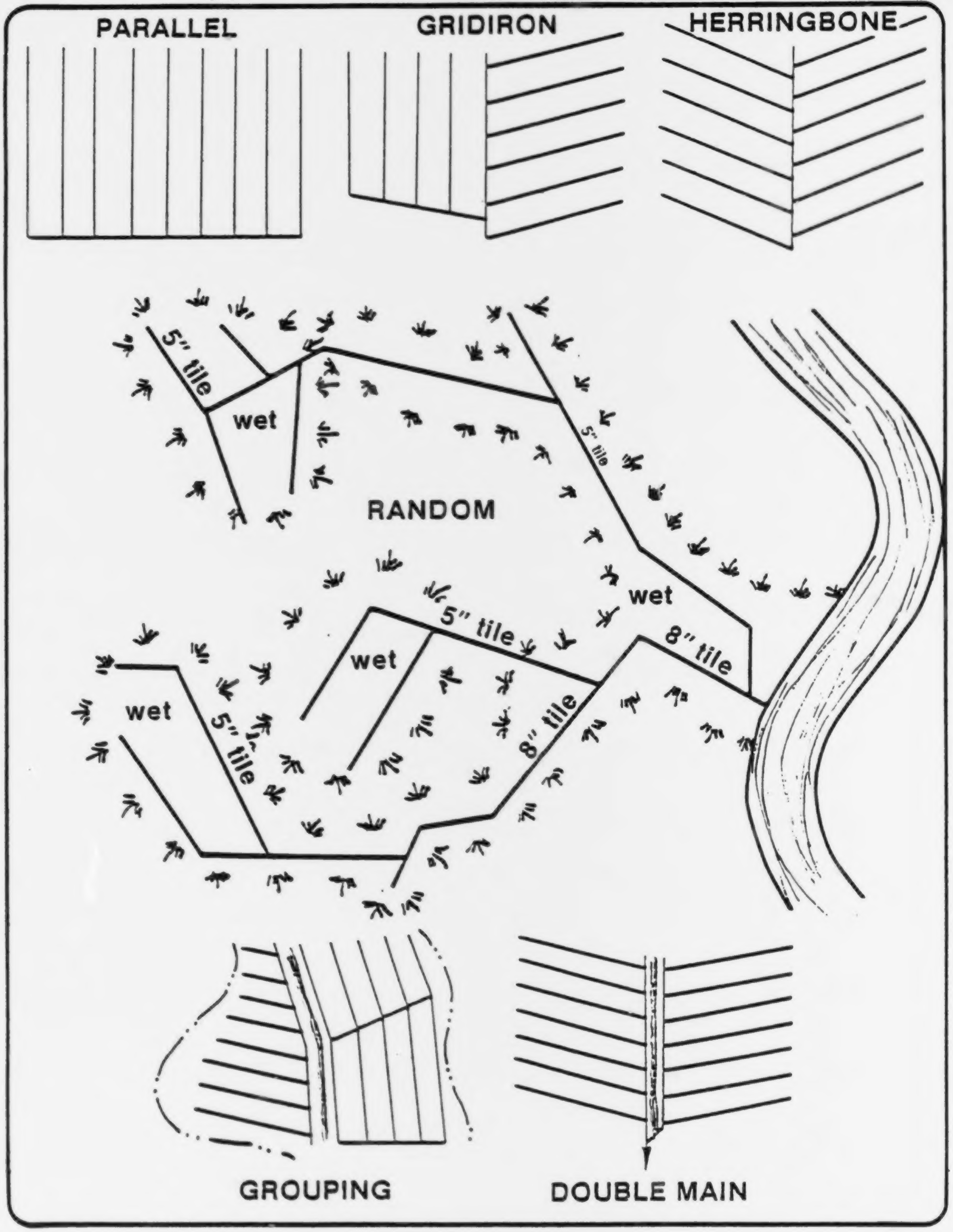
▬ ▬ ▬ ▬ Groundwater level 48 hours after rain

– – – – – Groundwater level in dry weather

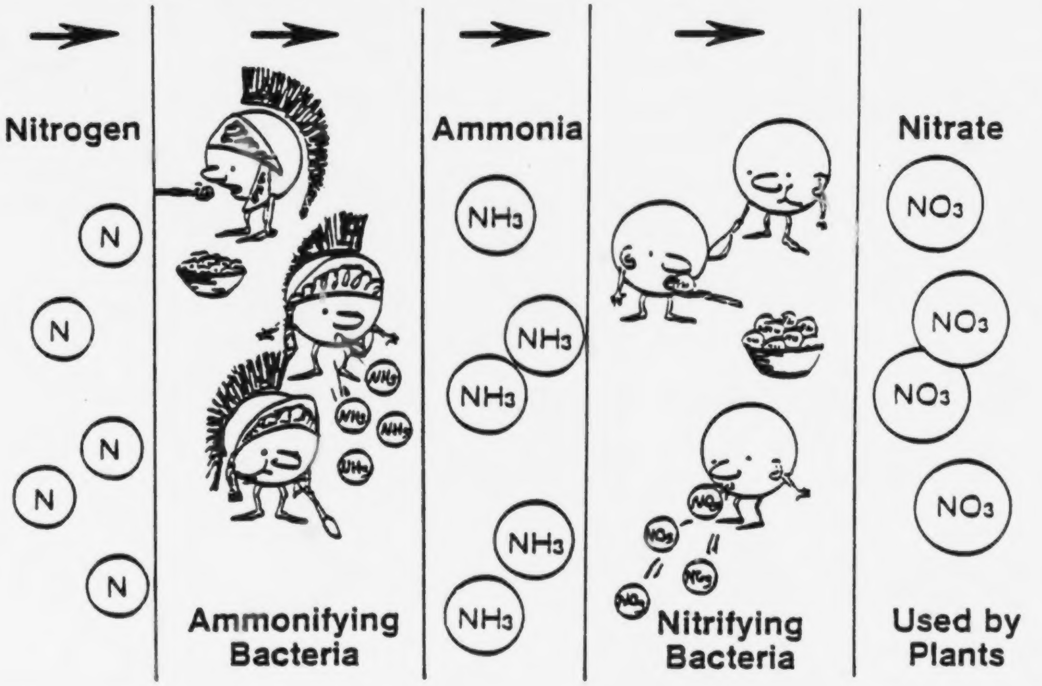

GOOD CROPS
AREA OF SEVERE CROP DAMAGE
GOOD CROPS

Drains spaced too far apart

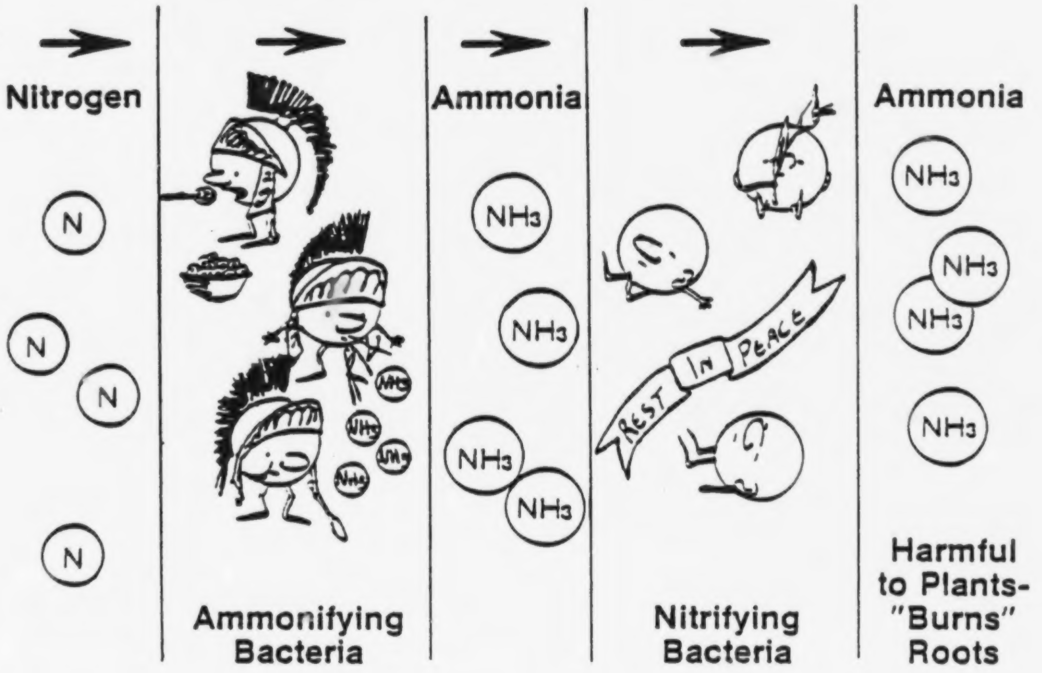
Types of Tile Drainage Systems


PARALLEL
GRIDIRON
HERRINGBONE
5" tile
wet
RANDOM
5" tile
wet
5" tile
wet
8" tile
wet
5" tile
8" tile
GROUPING
DOUBLE MAIN

Nitrifying Bacteria before Steaming


Nitrogen
N
N
N
N
N
Ammonifying Bacteria
Ammonia
NH_3
NH_3
NH_3
NH_3
NH_3
Nitrifying Bacteria
Nitrate
NO_3
NO_3
NO_3
NO_3
Used by Plants

Nitrifying Bacteria after Steaming


Nitrogen
N
N
N
N
Ammonifying Bacteria
Ammonia
NH_3
NH_3
NH_3
NH_3
REST IN PEACE
Nitrifying Bacteria
Ammonia
NH_3
NH_3
NH_3
NH_3
Harmful to Plants- "Burns" Roots

CHAPTER 3

PLANT GROWTH

PERFORMANCE CHECK LIST

1. List the parts of a plant and briefly explain the functions of each part.
2. Point out the differences between monocots and dicots as to seed germination and initial plant growth.
3. Explain the functions of xylem and phloem tissues in a plant.
4. Explain the functions of cambium cells in a plant.
5. Point out what happens to each growth zone of a growing plant.
6. Point out the differences between monocots and dicots in the function and location of vascular tissue.
7. Point out the differences in terminal and lateral growth habits of monocots and dicots.
8. Diagram the process of photosynthesis in plants. Include the naming of the inputs as well as the products of photosynthesis.
9. Demonstrate the effect of sunlight on starch formation in plant leaves.
10. Describe the effect of temperature on plants as it relates to photosynthesis.
11. List the three characteristics of light and the effect of each on photosynthesis.
12. List the effects of water and carbon dioxide on photosynthesis and explain how each of these factors might be controlled in the greenhouse.
13. Describe the process of transpiration in plants.
14. Demonstrate the effect of wind on transpiration.
15. Describe the process of respiration in plants.
16. Demonstrate how oxygen is used during respiration.
17. Describe the effects of photosynthesis, transpiration and respiration during the winter.
18. Describe the process of water movement into plants and the eventual loss of water by the plant.
19. Differentiate between active and passive absorption of water into plants.
20. Describe the process of sexual reproduction in plants.
21. Identify the reproductive parts of a plant (i.e., the parts of a flower).
22. Describe the reproductive cycle in plants.
23. Differentiate between self-pollination and cross-pollination in plants.
24. Demonstrate three methods of asexual plant reproduction.

SUGGESTED LEARNING ACTIVITIES

1. Test seed for germination.
2. Examine germinating seedlings at various stages of development.
3. Compare the root system of a monocot with that of a dicot.
4. Compare the stem structure of a monocot with that of a dicot.
5. Compare the flowers of a monocot with those of a dicot.
6. Compare the leaves of a monocot with those of a dicot.
7. Set up an experiment to demonstrate the need for light in photosynthesis. That is, grow a plant for several weeks in an area where it receives no light — in a closet, under a box, etc. Feed and water it normally. Compare this plant with one receiving adequate light.
8. Set up an experiment to demonstrate the effect of varying light levels on plant growth.
9. Set up a series of controlled experiments to demonstrate the effect of different temperatures on plants.

SAMPLE INTEREST APPROACH

Why are plants pruned? What would happen if Christmas tree nursery operators did not prune their trees?

Why are trees transplanted during the winter months? How does a "winter" tree differ from a "summer" tree?

Why do plants need water? What happens when a plant does not receive any water? What happens when a plant receives inadequate water? What would happen to a nursery operation if plants were not properly watered?

Why is a knowledge of plant growth important to nursery workers? What is a "green thumb"? How do people get "green thumbs"?

NAME ____________________

KEY QUESTIONS FOR CHAPTER 3

PART 1

Plant Anatomy

1. What are the two major functions of plant roots? (page 42)

   1) ____________________

   2) ____________________

2. What is the function of root hairs? (page 42)

3. What are the two major functions of plant stems? (page 42)

   1) ____________________

   2) ____________________

4. What is the major function of plant leaves? (page 42)

5. What is chlorophyll? (page 42)

6. Why is chlorophyll important to plants? (page 42)

7. Why are flowers colorful? (page 42)

Seeds and Seed Germination

8. What is the function of the scutellum? (page 43)

9. What is seed germination? (page 44)

NAME ______________________

PART 2

Plant Growth

1. List and describe the three major parts of a dicot stem. (page 46)

1) ____

2) ____

3) ____

2. Explain how the meristematic zone, zone of elongation, and zone of maturation differ (page 48)

____

____

____

3. List four of the ways in which monocots and dicots differ. (page 50)

1) ____

2) ____

3) ____

4) ____

Photosynthesis

4. Describe the process of photosynthesis. (pages 51-53)

____

____

____

5. How does temperature affect photosynthesis? (page 54)

____

____

6. How does light affect photosynthesis? (page 55)

____

____

7. What is light quality? (page 55)

____

8. What is light intensity and how is it measured? (page 55) ______________

____

____

9. What is photoperiod? (page 55)

____

____

NAME ______________________

PART 3

Transpiration

1. List four ways that water is important to plants. (page 56)

   1) ______________________

   2) ______________________

   3) ______________________

   4) ______________________

2. About how much of the water that enters plants escapes from the leaves and stems through transpiration? (page 56)

   ____

3. How do wind and temperature affect transpiration in plants? (page 57)

   ____

   ____

Respiration

4. What is plant respiration? (page 57)

   ____

   ____

5. What happens to the activities of photosynthesis, transpiration, and respiration in winter? (page 58)

   ____

   ____

   ____

NAME ____________________

PART 4

Water Movement into Plants

1. How does water get into plants? (pages 59-60)

____

____

2. How is water lost from plants? (pages 56-57)

____

____

3. How is active absorption of water into plants different from passive absorption? (page 60)

____

____

____

4. How much of the water absorbed by plants is absorbed through active absorption? (page 60)

____

5. What is cohesion? (page 59)

____

____

6. What is osmosis? (page 59)

____

____

NAME ____________________

PART 5

Plant Reproduction

1. What is the difference between sexual and asexual reproduction of plants? (pages 61, 65)

2. List the 12 parts of a flower, and describe the function of each part. (pages 61-62)

1) ____________________

2) ____________________

3) ____________________

4) ____________________

5) ____________________

6) ____________________

7) ____________________

8) ____________________

9) ____________________

10) ____________________

11) ____________________

12) ____________________

3. What is a cross-pollinated plant? (page 62)

4. What is the difference between a perfect and an imperfect flower? (page 64)

5. What are adventitious roots and what function do they serve? (page 65)

6. What is the difference between a stolon and a rhizome? (page 65)

NAME ____________________

TERMS TO REMEMBER - Chapter 3

PART 1

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 3 of *The Nursery Worker*.

Technical Vocabulary

adventitious root
anther
axillary bud
chlorophyll
cotyledon
footcandle
imbibition
ovary
phloem
placenta
plumule
scutellum
stolon
turgid
xylem

____________________ 1. A root produced in an unusual place or part of a plant; typically roots produced on above-ground plant parts. (page 65)

____________________ 2. A small plate or shieldlike part of a root. (page 43)

____________________ 3. A unit of light equivalent to the light produced by one candle at a distance of one foot. (page 55)

____________________ 4. A green pigment found in plants. (page 42)

____________________ 5. A bud found in the axil of a leaf. (page 65)

____________________ 6. The first leaf or leaves in a seed. (pages 43–44)

____________________ 7. The absorption of liquid or moisture. (page 46)

____________________ 8. In a flower, the basal part of the pistil which develops into the fruit. (pages 61–64)

____________________ 9. Meristem cells in the bark of woody plants next to the cambium. Conduct food downward. (pages 46–48)

____________________ 10. The primary bud of an embryo or germinating seed plant. (page 43)

____________________ 11. The reproductive organ of the male pollen-bearing flower. (page 62)

____________________ 12. Having adequate moisture in plant cells. (glossary)

____________________ 13. Water-conducting woody tissue in higher plants. (pages 46–48)

____________________ 14. A stem growing horizontally on or just below the surface of the ground. (page 65)

____________________ 15. The part of the ovary of flowering plants which bears the ovules. (page 62)

NAME ____________________

TERMS TO REMEMBER - Chapter 3

PART 2

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 3 of *The Nursery Worker*.

Technical Vocabulary

bark
calyx
corolla
meristematic zone
pedicel
photoperiod
photosynthesis
radicle
respiration
sexual reproduction
stigma
style
transpiration
vascular tissue
wood

____________________ 1. The manufacture of carbohydrates (food) from carbon dioxide and water in the presence of light and chlorophyll. (pages 51-53)

____________________ 2. The external, leafy part of a flower made up of sepals. Usually green. (page 62)

____________________ 3. The exterior tissue or covering of a woody trunk or stem. (page 46)

____________________ 4. The petals of a flower. (page 62)

____________________ 5. Area of embryonic tissue with actively growing and dividing cells. (page 48)

____________________ 6. The stem or stalk of a flower. (page 61)

____________________ 7. The lower part of an embryo seedling. (page 43)

____________________ 8. A prolongation of the ovary that supports the stigma, where pollen grains are received. (pages 61, 62)

____________________ 9. Tissue (xylem and phloem) which translocates food and water within the plant. (page 48)

____________________ 10. Structural cells in the stems of trees and shrubs. (pages 46-47)

____________________ 11. The emission of water vapor from the aerial parts of a plant chiefly through leaf stomates. (pages 56-58, 60)

____________________ 12. The part of the pistil in a flower which receives pollen grains. (pages 61, 62)

____________________ 13. Reproduction of plants by seeds. (pages 61-64)

____________________ 14. The process of carbohydrate utilization by a living organism. (pages 57-59)

____________________ 15. The time during which a plant is exposed to daylight. (page 55)

NAME ____________________

TERMS TO REMEMBER - Chapter 3

PART 3

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 3 of *The Nursery Worker*.

Technical Vocabulary

- annual
- biennial
- capillary action
- carbohydrates
- cross-pollination
- cuticle
- guard cell
- node
- nutrient
- palisade mesophyll
- perennial
- perfect flower
- self-pollination
- sepal
- vascular bundle

____________________ 1. A plant that continues to live from year to year. (page 62)

____________________ 2. The layer of cells just beneath the upper surface of the leaf. (page 54)

____________________ 3. Either of two cells that flank the stomate and cause it to open and close. (page 54)

____________________ 4. Organic compounds that form the supporting tissues of plants. Important food for animals and people. (glossary)

____________________ 5. A plant that completes its life cycle in one year. (page 62)

____________________ 6. A plant that produces leaves the first year of its life, and flowers, fruit, and seeds the second year; then dies. (page 62)

____________________ 7. The upward movement of water in soil resulting from the attraction of water molecules to each other and to the soil particles. (glossary)

____________________ 8. The contact of pollen from one plant with the stigma of a different plant. (pages 62, 64)

____________________ 9. The thickened waxy surface layer of certain leaves, fruits, and shoots. (page 51)

____________________ 10. A joint on a stem where a bud, leaf, or flower stalk is attached. (pages 46, 48)

____________________ 11. A substance which a plant synthesizes into food. (glossary)

____________________ 12. A flower containing both staminate (male) and pistillate (female) parts. (page 64)

____________________ 13. One of the "leaves" of a calyx. (page 62)

____________________ 14. In stems, a group of tissue strands. (pages 48, 54)

____________________ 15. Pollinated by the anthers of the same flower. (pages 62, 64)

NAME ______________________

TERMS TO REMEMBER - Chapter 3

PART 4

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 3 of *The Nursery Worker*.

Technical Vocabulary

asexual reproduction	mesocotyl
dicot	monocot
embryo	pistil
endosperm	pith
filament	rhizome
hypocotyl	root hair
imperfect flower	stamen

______________________ 1. A hair-like outgrowth from near the tip of a rootlet, performing the work of absorption. (pages 42, 59-60)

______________________ 2. An underground rootlike stem. (page 65)

______________________ 3. The spongy tissue within a stem. (pages 46, 48)

______________________ 4. A plant that produces seeds containing a single cotyledon or seed leaf. (page 50)

______________________ 5. The female part of a flower comprised of the ovary, stigma, and style. (pages 61, 62)

______________________ 6. Specialized cells located between the scutellum and the coleoptile. (page 44)

______________________ 7. A flower containing only the staminate (male) or pistillate (female) flower parts, but never both. (page 64)

______________________ 8. The anther-bearing stalk of a stamen. (page 62)

______________________ 9. In the embryo of a plant, the part of the stem below the cotyledons. (pages 43, 45)

______________________ 10. A part of the seeds of certain plants which consists of food materials. (pages 43, 44)

______________________ 11. A plant which produces seeds with two cotyledons or seed leaves. (page 50)

______________________ 12. Plant reproduction without the use of seeds. (pages 65-66)

______________________ 13. The part of a seed that, upon germination, grows and develops into a plant. (page 43)

______________________ 14. The reproductive organ of the male pollen-bearing flower. (pages 61, 62)

Crossword Puzzle 3 Clues

ACROSS Clues

1. The ________ mesophyll is a layer of elongated cells just beneath the upper surface of the leaf. (page 54)
4. The first leaf to emerge from a seed. (pages 43-44)
5. The base part of a flower pistil which develops into a fruit. (pages 61-64)
9. The lower portion of an embryo seedling. (page 43)
10. A portion of the seed containing stored food. (pages 43-44)
13. A small plate or shieldlike part of a root. (pages 43-44)
14. The portion of stem from which buds, leaves, or flower stalks arise. (pages 46, 48)
15. Bark cells that conduct manufactured food downward in the plant. (page 46)
17. The water-conducting tissue of woody plants. (page 46)
18. A plant which has two cotyledons. (page 50)
22. Loss of water vapor from the above-ground portions of plants. (pages 56-57)
23. An underground rootlike stem. (page 65)
24. The part of the ovary of flowering plants which bears the ovules. (page 62)
25. A pore in the surface of a leaf through which gases and water vapor pass. (page 54)

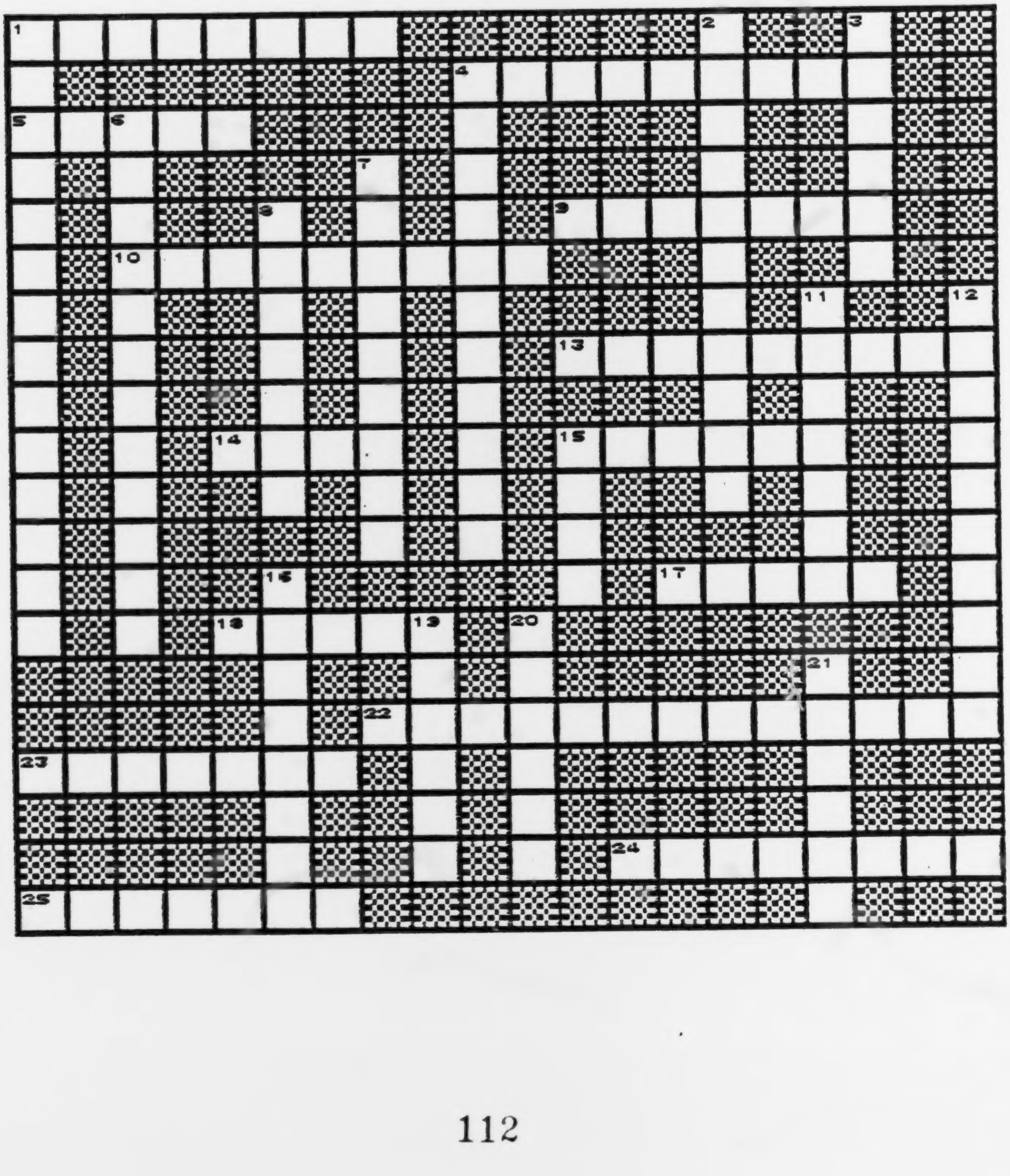
DOWN Clues

1. The food manufacturing process in plants. (page 51)
2. The process of using carbohydrates and the resulting release of energy. (page 57)
3. A male portion of a flower. (page 62)
4. A green pigment found in plants (page 42)
6. A root produced in an unusual part of a plant such as on an above-ground stem. (page 65)
7. A flower which lacks either male or female parts. (page 64)
8. A plant which produces only one cotyledon. (page 50)
11. The primary bud of a germinating seed plant. (page 43)
12. The process by which seeds absorb water. (page 46)
15. The spongy tissue in stems. (page 46)
16. Part of a stamen. (page 62)
19. Having adequate moisture in plant cells. (glossary)
20. A plant that completes its life cycle in one year. (page 62)
21. The reproductive organ of the male pollen-bearing flower. (pages 61, 62)

NAME ____________________

CROSSWORD PUZZLE 3

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker*.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25

3-14

NAME ____________________

LETTER MAZE 3

The 40 words listed below are hidden in this letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
N P W J U I B G M M F V V D P H O T O S Y N T H E S I S X C Y U
Y K O G K G D U M G X E M M J S I H U T O B E F O E A J S L X K
Q U T O P Y F T L J H H T M C F U Y L I H R I C N B E I F H A P
A C S T Z G X R P I P U L F P P Q L T Z Z S A K T K G I G F U I
M E S O C O T Y L T H W I H T A Y A Q I M S Y C P Q C E R K B S
R W T U S C U T E L L U M U O H R L D R C U I E O H E Z I I A Y
V M D U M Q P V C T D F Q Z P I R G I K Q Q T B M R D N Y I U S
O Z T W E W S J Y Q Z H W O P M O Q B O Y A V E N D O S P E R M
B S A W R C C Y T N K T R S I Y T E J T R Y F V U I F L Y Y Z D
Z T I H I Y I M M W U O E P R F F S C D O C O J T A K V L A R Q
R A P I S E F N U S L R X B T Q B H Y E B V U I B F M G B A S F
J M X V T I K X U H S E M Q J W S H V D O W B T E V M G X P E A
A E U A E B X Q C G L E W C L A O A G V A I L P I T H Y H S P V
W N P G M K A X B C K M S Y D B D F D T B A W D N C L V M R A G
Z X X S B L J N I C J P T D R D N X N M I B X V X A L I P J L D
D T W E L T F D T M E O D A J X H E I N U T I L C F O E L W O F
B F V E K M A K D H C T C P S G C J N B L C W E N C J I U K K I
L E B H W R G W P O E N X U D A P E S T I G M A N O G K M U M J
E G I G N V F N P Z E R O O L W R I K B T X X C L N D M U B D E
H U H A N W N Y E F T I I P P E X R S W L W G P M I I E L A W T
W S L G H Z H K P R T R N X P Y X T R T M J H G Y K X A E R P O
T R E M P H J V M I E O A K H B Q B T S I O U A Y D B Y L K P A
Z N W T C H G D T P D E M N S T O L O N E L N N H J I C J W Z G
Z O Q F T I A N O E L L F C S F I L A M E N T O P V H C N T C I
N B S H Z I E T L D Q O F Z C P Y Y H L O V R E C E O R O T U F
I W B F L V O Y N Q K D F V V K I A J O R Z B R S O D A A T A A
E B A L D H T A B R G I Y S P K A R H V S T O H H I T I G M V Z
F H U A P O C Z W Z T P S H M U V B A G S R A I R S N A C E F X
L I T Q C T P H L O E M B S L M Z X S T K X T Z C G Q V A E S I
Y Y D Q O S A N W O D H A U K K M G X Y I S C O O L L N M Q L D
Z N Z O S C M P Z B M L V L X D O L H S R O Y M A N N U A L I Z
B Q F A T Y V M T R O A E N D T Q L Y S D B N E W T X W U G E I
```

ADVENTITIOUS
ANNUAL
ANTHER
BARK
BIENNIAL
CALYX
CARBOHYDRATE
CHLOROPHYLL
COROLLA
COTYLEDON
CUTICLE
DICOT
EMBRYO
ENDOSPERM

FILAMENT
FOOTCANDLE
HYPOCOTYL
IMBIBITION
MERISTEM
MESOCOTYL
MONOCOT
NODE
PEDICEL
PERENNIAL
PHLOEM
PHOTOPERIOD
PHOTOSYNTHESIS

PISTIL
PITH
PLACENTA
PLUMULE
RADICLE
RESPIRATION
RHIZOME
SCUTELLUM
SEPAL
STAMEN
STIGMA
STOLON
TRANSPIRATION

NAME ____________________

STUDENT EXERCISE 3-A

THE FORMATION OF STARCH

Plant physiologists tell us, "Sugar produced through photosynthesis is quickly converted to starch." Let's put this statement to the test.

MATERIALS:

- a growing geranium plant
- rubbing alcohol
- pint Mason jar
- small dish
- small pot
- stove or Bunsen burner
- paper towels
- tincture of iodine
- water
- measuring cup
- black paper
- paper clips

PROCEDURE:

1. Make "sandwiches" out of the black paper and two of the leaves *on the plant*. (Don't break them off.) In other words, cover the top and bottom of each leaf with black paper. Use the paper clips to hold the three layers together to keep light from hitting the leaf. Leave the plant with these covered leaves in sunlight for about three days.
2. About three hours before your class starts on the fourth day, remove the paper from one of the leaves and with it exposed, put the plant back in sunlight for two or three hours.
3. During class that day, cut off the leaf that still has the black paper on it and remove the paper. Place one-third cup of alcohol in the pint jar and place this leaf in the jar. Place the jar in a pot that has boiling water in it and allow the water to simmer for 15 minutes. Remove the jar and allow the alcohol to cool; then remove the leaf. Blot it with paper towels and put it in a small dish.
4. In one-fourth cup of water add one tablespoon of tincture of iodine. Pour some of this iodine mixture over the leaf. Record the color of the leaf.
5. Now repeat steps 3 and 4 with the leaf that has been in the light for two or three hours. Record the color of this leaf.

INTERPRETATION:

Iodine stains starch a blue-black to deep purple color. Boiling the leaves in alcohol removed the chlorophyll so that only the starch remained.

The results of your experiment should have been as follows:

1. The leaf that had been covered and kept from exposure to sunlight contained very little starch (as shown by no change to a slight change in the color of the iodine mixture). Because it was covered up with black paper, the leaf used up the starch that had been produced earlier.
2. The leaf that had been exposed for two to three hours had some time for photosynthesis to take place. Starch *was* present (as indicated by the change in color of the iodine solution).

This should make it quite clear that with sunlight present, a plant carries on photosynthesis and thus makes food for itself in the form of starch.

EVALUATION:

1. The demonstration was conducted as directed. ____________
2. All materials used were cleaned and properly stored. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 3-B

THE EFFECT OF WIND ON TRANSPIRATION

About 99 percent of all water that enters a plant escapes from the leaves as water vapor. This process is called transpiration. In this exercise you will demonstrate the effect of wind on transpiration.

MATERIALS:

- 2 geranium plants in pots
- weighing scales
- plastic bags or aluminum foil and twist-ties
- fan

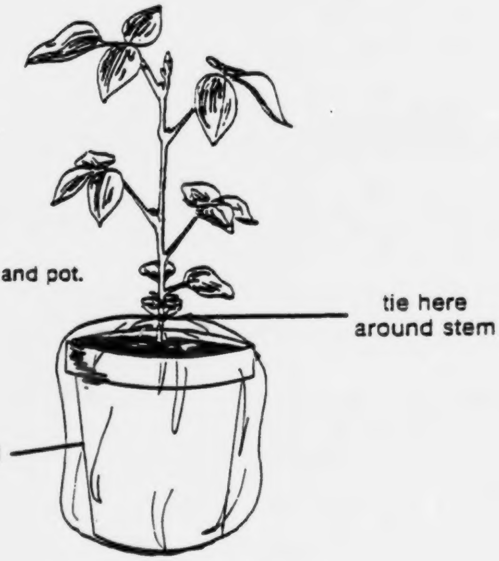


Figure 3-1. Plastic bag tied around plant and pot.

PROCEDURE:

1. Weigh the two potted geranium plants and record the weight of each.
2. Cover each pot with a plastic bag or aluminum foil up to the stem so that none of the water evaporates from the pot itself (Figure 3-1).
3. Leave one of the plants in normal conditions of air movement. Place the other plant directly in the breeze from a fan. Make sure that the fan breeze does not batter the plant but does create a steady flow of air around the plant.
4. For three days, weigh each plant once a day and record the weight.
5. Calculate the amount of water lost from each plant through transpiration. Also calculate the percentage of water lost by each plant through transpiration.

	Initial Weight	1st Day Weight	Difference	2nd Day Weight	Difference	3rd Day Weight	Difference	Total % Difference
PLANT 1								
PLANT 2								

(continued)

Student Exercise 3-8 *(continued)*

INTERPRETATION:

If your experiment was set up correctly and other conditions were similar, the plant placed in the breeze should have lost more water through transpiration than the other plant. The reason for this should be clear. The "wind" blowing across the leaves of the plant increased the rate of evaporation of water from the leaves. As this water evaporated, more water was drawn from the soil into the plant through the roots and was eventually lost. The plant that was out of the breeze from the fan lost some water by transpiration, but not as great a percentage.

EVALUATION:

1. Demonstration was conducted as directed. ______________
2. All materials used were cleaned and properly stored. ______________

FINAL GRADE _________

NAME ____________________

STUDENT EXERCISE 3-C

UTILIZATION OF OXYGEN IN RESPIRATION

Oxygen is used by plants during respiration. The following exercise should illustrate this.

MATERIALS:

- 10 bean or pea seeds
- plastic bag
- paper towels
- alkali solution (see *Procedure* step #2)
- one 2-ounce medicine bottle with a rubber stopper (with a hole in it)
- glass tube
- 3 pipe cleaners
- millimeter ruler

PROCEDURE:

1. Four days before needed, soak the seeds in water for two days. Change the water once each day. Then wrap the seeds in wet paper towels and place them in a plastic bag at room temperature for two more days.
2. Make the alkali solution by dissolving 1 tablespoon household lye in ¼ cup water. ***CAUTION:*** This solution can cause burns. **Keep it away from your eyes! Wash immediately** if you get some solution on your hands.
3. Place the ten germinating seeds in the medicine bottle and lay the bottle on its side.
4. Fix the pipe cleaners on the stopper as shown in Figure 3-2. Dip the ends of the pipe cleaners into the alkali solution.

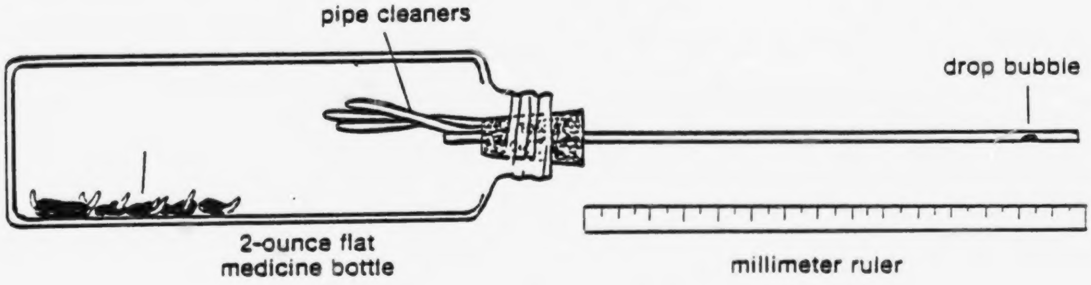


Figure 3-2. Set-up of bottle for respiration experiment.

5. Insert the glass tube into the rubber stopper and insert the stopper into the bottle.
6. Place a drop of colored water at the end of the glass tube.
7. Carefully lay the ruler alongside the glass tube so you can read the distance on the ruler as the bubble moves.
8. As soon as you place the drop of colored water at the end of the glass tube, begin timing at 0. Measure the distance the bubble moves at the end of 10, 20, 30, 40, 50, and 60 minutes.
9. Record the data on the graph in Figure 3-3, making points on the graph; then connect the points to show a curve.

(continued)

Student Exercise 3-C *(continued)*

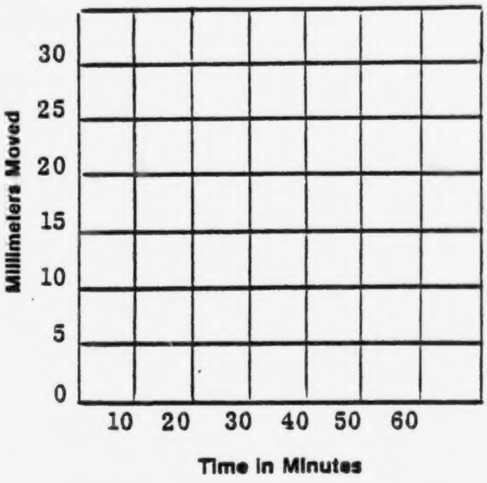


Figure 3-3. Graph of bubble movement.

INTERPRETATION:

If you refer to the equation for respiration (page 57 in the Student Manual), you will see that 6 carbon dioxide molecules are being produced by using up 6 oxygen molecules. Since they are both gases, one would replace the other and there would be no change in the pressure in the bottle. An alkali solution absorbs any free carbon dioxide that is around. The lye solution on the pipe cleaners absorbed the carbon dioxide that was being produced, so there was a lowering of pressure in the bottle as the oxygen was used up in respiration. This lowering in pressure caused the bubble in the glass tubing to move toward the lower pressure, making it possible to measure the oxygen being used.

When did your curve begin its sharpest rise? Can you explain why?

____

____

EVALUATION:

1. The experiment was conducted as directed. ____________
2. All materials used were cleaned and stored properly. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 3-D

OSMOSIS

Water moves from an area of higher concentration (of water) to an area of lower concentration (of water). This process is called *osmosis*. In this exercise you will demonstrate how osmosis occurs in plants.

MATERIALS:

- thistle tube
- semi-permeable membrane
- sugar
- string or rubber band
- beaker containing water
- ring stand

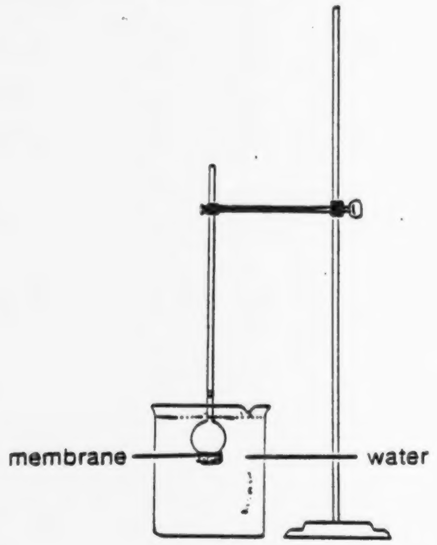


Figure 3-4. Set-up for osmosis experiment.

PROCEDURE:

1. Dissolve some sugar in about ½ cup of water,
2. Stopper the tube end of the thistle tube. Pour sugar water into the tube until the bulb is about half full.
3. Securely tie the membrane on the bulb end of the thistle tube.
4. Invert the bulb end in the beaker of water and hold in place with ring stand (Figure 3-4).
5. Place a mark on the outside of the tube at the sugar water level.
6. Place new marks on the tube at the end of 5, 10, 20, and 30 minutes.

INTERPRETATION:

Each cell in a plant or animal has a cell wall. Most of these cell walls are made of **semi-permeable membranes**, that is, membranes through which liquids and certain dissolved minerals can move without an opening being present in the wall. It is a known fact that water moves from an area of higher concentration (of water) to an area of lower concentration (of water).

The concentration of water was greater in the beaker. Water moved across the semi-permeable membrane into an area of lower water concentration. When sugar was added to the water in the tube, it increased the total volume of liquid. Therefore, the amount of water in the tube became diluted, or it had a lower concentration of actual water for its total volume.

Now, as water is lost in the leaves through transpiration, the concentration of actual water in the cells in the leaf is lowered. The water in the cells next to these cells moves into the area of lower concentration.

(continued)

Student Exercise 3-D *(continued)*

Next the cells that just contributed some water are lower in their water concentration, so cells lower in the branch or stem contribute water to them, and the process moves down the tree all the way to the roots and soil. In this way, water moves to the top of the tree (Figure 3-5).

With the interacting forces of cohesion (sticking together) of water molecules, and the tendency of water molecules to move from an area of higher concentration to an area of lower concentration, water moves upward in the plant. This could be compared to a chain reaction. However, these forces are not acting only one cell at a time. This is usually taking place at the same time throughout the entire height of the tree, causing an almost steady upward flow of water.

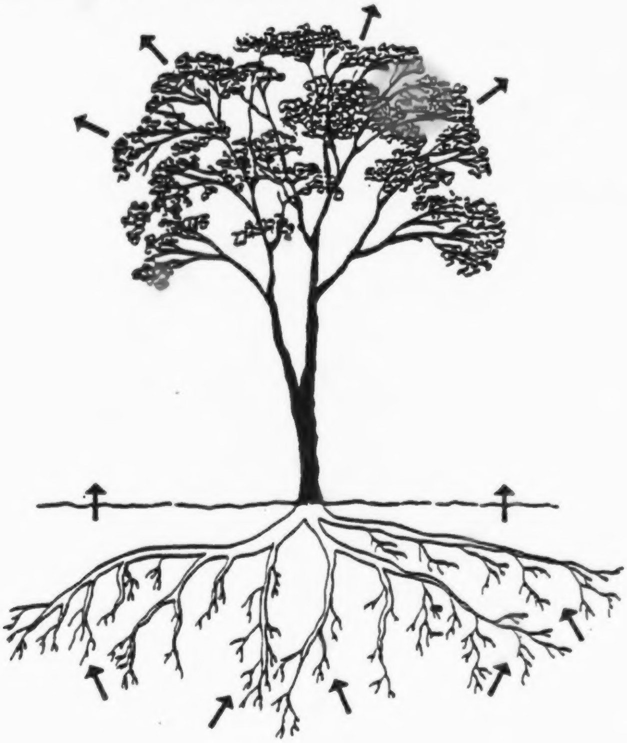


Figure 3-5. Water moving up the tree by osmosis.

EVALUATION:

1. The experiment was conducted as directed. ______________
2. All materials used were cleaned and stored properly. ______________

FINAL GRADE ________

NAME ______________

STUDENT EXERCISE 3-E

CHARACTERISTICS OF FOUR COMMON PLANT PROCESSES

The purpose of this exercise is to organize the information regarding **photosynthesis, respiration, transpiration,** and **absorption**. In your notebook, reproduce this table and fill in the information as shown by the column headings.

Plant Process	Materials and Conditions Needed	Plant Structures Involved	Results
Photosynthesis			
Respiration			
Transpiration			
Absorption			

EVALUATION:

1. Chart was constructed and completed as directed. ______________

FINAL GRADE ________

NAME ______________________

QUIZ - CHAPTER 3

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. Leaves are the food-manufacturing organs of plants.

T F 2. Dicots have two cotyledons.

T F 3. The woody area of a branch or stem contains the xylem tissue.

T F 4. The main function of the cuticle is to prevent gases and water from entering and leaving leaves.

T F 5. Light quality refers to the color of light.

T F 6. Light intensity refers to the brightness or quantity of light.

T F 7. Light intensity is measured in footcandles.

T F 8. Plant respiration does **not** occur during the night.

T F 9. Photosynthesis does **not** occur during the night.

T F 10. Deciduous plants stay green all winter.

T F 11. When the transpiration rate is very high, plants may lose more water than they take in.

T F 12. Monocots have a fibrous root system.

T F 13. The leaves of dicots have radiating or netted veins.

T F 14. Transpiration in plants is like sweating in people.

T F 15. *Optimum* means "the best."

MULTIPLE CHOICE

Read each item and decide which choice correctly completes the statement or answers the question. Circle the letter of your choice.

16. Which of the following is/are a function of plant roots?

A. they anchor plants in the soil
B. they absorb nutrients from the soil
C. they absorb moisture from the soil
D. all of the above

17. A cotyledon is . . .

A. a seed leaf
B. a root
C. a type of flower
D. the female part of a flower

18. The manufacture of food (or energy) in plants is called . . .

A. osmosis
B. photosynthesis
C. transpiration
D. respiration

19. Carbon dioxide from the atmosphere is taken into plants through . . .

A. endosperm
B. stomates
C. coleoptiles
D. vascular bundles

QUIZ - page 2

20. The passing of water vapor out of plants through the cells is called . . .

    A. transpiration
    B. respiration
    C. photosynthesis
    D. geotropism

21. The male part of a flower is the . . .

    A. pedicel
    B. calyx
    C. stamen
    D. sepals

22. The female part of a flower is the . . .

    A. pistil
    B. anther
    C. filament
    D. petal

23. Plants which grow and reproduce in one growing season and then die are called . . .

    A. perennials
    B. biennials
    C. annuals
    D. deciduous

24. Flowers which contain both male and female parts are said to be . . .

    A. perfect
    B. imperfect
    C. asexual
    D. adventitious

25. Rhizomes are . . .

    A. roots
    B. stems
    C. flowers
    D. specialized leaves

MATCHING

Select a definition from Column B which matches each term in Column A. Fill in each blank with the correct letter.

Column A	Column B
______ 26. phloem	A. food-absorbing organ
______ 27. imbibition	B. the place where a bud arises
______ 28. scutellum	C. tip of the embryo shoot
______ 29. hypocotyl	D. upward conducting tissue
______ 30. epidermis	E. downward conducting tissue
______ 31. xylem	F. water absorption
______ 32. node	G. perfect flower
______ 33. plumule	H. both xylem and phloem
______ 34. vascular tissue	I. where cells are dividing
______ 35. meristematic zone	J. embryonic stem
	K. outer layer of cells

QUIZ - page 3

36. Label each flower part and record your answers in the blanks provided.

A. ______________________________

B. ______________________________

C. ______________________________

D. ______________________________

E. ______________________________

F. ______________________________

G. ______________________________

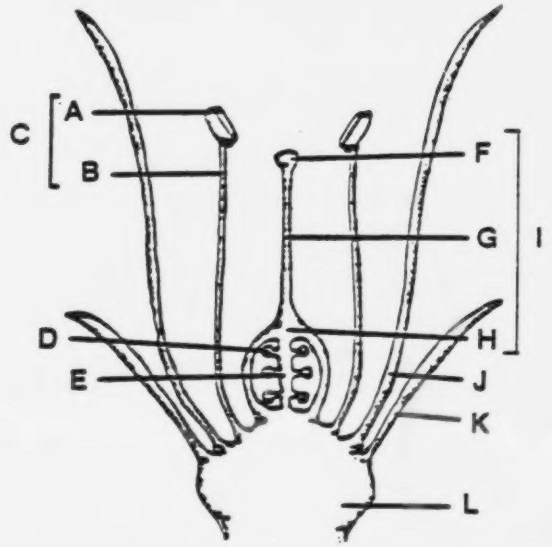
H. ______________________________

I. ______________________________

J. ______________________________

K. ______________________________

L. ______________________________


A
B
C
D
E
F
G
H
I
J
K
L

PARTS OF A FLOWER

ANSWER KEY - CHAPTER 3

Key Questions, Part 1 - page 3-3

PLANT ANATOMY

1. (1) Roots anchor plants in soil, holding them up. (2) Once a plant is established in soil the roots absorb moisture and nutrients from the soil.
2. Root hairs absorb water and nutrients.
3. (1) Stems support plants above ground and provide support for leaves. (2) They also provide the major channels for movement of moisture and nutrients upward into leaves and movement of food to storage areas.
4. Leaves manufacture food for the plants.
5. Chlorophyll is a green pigment found in plants.
6. Chlorophyll is needed for photosynthesis (the manufacture of food).
7. Most flowers are colorful so that insects will be attracted to the plant and assist in pollination.

SEEDS AND SEED GERMINATION

8. The scutellum serves as a food-absorbing organ in the seed.
9. Germination is the beginning of seed growth.

Key Questions, Part 2 - page 3-4

PLANT GROWTH

1. (1) Pith - the innermost zone of the stem. Stores food that is produced in the leaves and helps support the plant.
   (2) Wood - contains xylem tissue which conducts dissolved nutrients and water upward.
   (3) Bark - outer zone serving as a protected area for growing cells. Contains phloem (which conducts food downward) and cambium (the area where outward growth is taking place).
2. The meristematic zone is where cells are dividing. The zone of elongation is where cells grow and increase in size. The zone of maturation is where growing cells mature (and become specialized).
3. (1) Monocots have one cotyledon (seed leaf); dicots have two.
   (2) In monocots the stored food of the seed is in the endosperm; in dicots the stored food of the seed is in the cotyledons.
   (3) Monocots have a fibrous root system; dicots often have a much-branched, well-developed tap root system.
   (4) Monocots have no cambium in mature stems; dicots have a cambium in mature stems.
   (5) Monocot leaves are generally simple with parallel veins; dicot leaf shapes vary greatly and usually have radiating or netted veins.
   (6) In monocots flower petals and sepals are often identical; in dicots flower petals and sepals are usually different.
   (7) In monocots flower parts are in multiples of 3; in dicots flower parts are in multiples of 4 and 5.

PHOTOSYNTHESIS

4. Using chlorophyll (in the presence of light), with the raw ingredients carbon dioxide and water, plants manufacture food (sugar) and oxygen.
5. All growth processes in plants take place within a limited range of temperatures. *Below* the minimum temperature or *above* the maximum temperature all plant growth stops.
6. Light must be present for photosynthesis to take place in plants.
7. Light quality refers to the color of light.
8. Light intensity is the brightness or quantity of light. It is typically measured in footcandles.
9. Photoperiod refers to light duration or the amount of time that plants are in light.

Answers *(continued)*

Key Questions, Part 3 - page 3-5

TRANSPIRATION

1. (1) Water plays a key role in plant transpiration.
   (2) Water is the major ingredient of all cells.
   (3) Water is necessary for all chemical reactions in cells.
   (4) Water in soil dissolves minerals so they can move into plants.

2. About 99% of the water that enters plants escapes from the leaves and stems as water vapor.

3. Wind and high temperature can increase the rate of transpiration (water loss) in plants.

4. Respiration is the breaking down or controlled utilization (burning) of food to produce energy for plant processes.

5. In deciduous plants photosynthesis stops in winter when plants lose their leaves; respiration and transpiration slow down. In evergreens photosynthesis may continue when the winter temperatures are warm enough; respiration and transpiration are usually low.

Key Questions, Part 4 - page 3-6

WATER MOVEMENT INTO PLANTS

1. Water gets into plants from the soil through the roots.

2. Water is lost from plants through transpiration.

3. Active absorption is essentially the same process as cohesion. When soil moisture is high and transpiration is taking place slowly in the plant, water from the soil moves (diffuses) through the cell walls of root hairs into the root hair cells.

   Passive absorption depends upon the forces of pressure. When the transpiration rate is very high, plants may be losing more water than they are taking in. This in turn lowers the pressure in the cells. Water in the soil is under normal pressure. This causes soil water to move into plant cells.

4. Cohesion is the sticking together of water molecules.

5. Osmosis is the process of water moving from an area of higher concentration (of water) to an area of lower concentration (of water).

Key Questions, Part 5 - page 3-7

PLANT REPRODUCTION

1. Sexual reproduction in plants involves seeds. Asexual reproduction involves some other plant part.

2. (1) **pedicel** - a specialized flower stem

   (2) **calyx** - a group of sepals

   (3) **sepals** - plant parts that cover and protect delicate flower parts within the bud until it is ready to open or bloom

   (4) **petals** - plant parts that are often colored, attracting insects

   (5) **corolla** - a group of petals

   (6) **stamen** - the male part of the flower

   (7) **filament** - the elongated stalk of the stamen

   (8) **anther** - contains the pollen grains

   (9) **pistil** - the female part of the flower

   (10) **stigma** - the sticky tip of the pistil that receives the pollen grains

   (11) **style** - a tube-like structure that pollen travels through to fertilize the eggs

   (12) **ovary** - contains eggs to be fertilized

Answers *(continued)*

3. In cross-pollinated plants the pollen from one plant contacts the stigma of a different plant.
4. Perfect flowers contain both male and female parts. Imperfect flowers contain only the male or female part, not both.
5. Adventitious roots are roots that arise at a place where roots would not normally be expected.
6. Stolons are above-ground stems or runners such as those found on strawberries. Rhizomes are underground stems such as those found on iris.

Terms to Remember, Part 1 - page 3-8

1. adventitious root
2. scutellum
3. footcandle
4. chlorophyll
5. axillary bud
6. cotyledon
7. imbibition
8. ovary
9. phloem
10. plumule
11. anther
12. turgid
13. xylem
14. stolon
15. placenta

Terms to Remember, Part 2 - page 3-9

1. photosynthesis
2. calyx
3. bark
4. corolla
5. meristematic zone
6. pedicel
7. radicle
8. style
9. vascular tissue
10. wood
11. transpiration
12. stigma
13. sexual reproduction
14. respiration
15. photoperiod

Terms to Remember, Part 3 - page 3-10

1. perennial
2. palisade mesophyll
3. guard cell
4. carbohydrates
5. annual
6. biennial
7. capillary action
8. cross-pollination
9. cuticle
10. node
11. nutrient
12. perfect flower
13. sepal
14. vascular bundle
15. self-pollination

Terms to Remember, Part 4 - page 3-11

1. root hair
2. rhizome
3. pith
4. monocot
5. pistil
6. mesocotyl
7. imperfect flower
8. filament
9. hypocotyl
10. endosperm
11. dicot
12. asexual reproduction
13. embryo
14. stamen

Crossword Puzzle - page 3-13

ACROSS

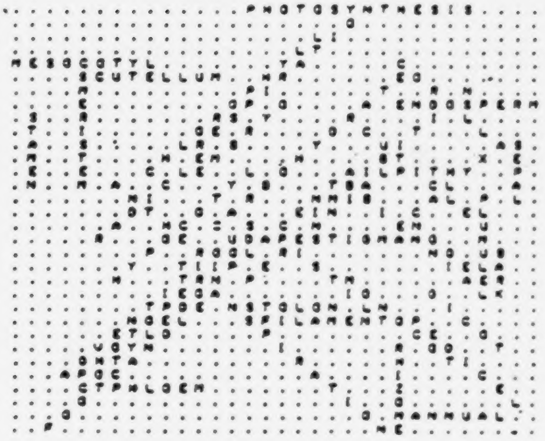
1. palisade
4. cotyledon
5. ovary
9. radicle
10. endosperm
13. scutellum
14. node
15. phloem
17. xylem
18. dicot
22. transpiration
23. rhizome
24. placenta
25. stomate

DOWN

1. photosynthesis
2. respiration
3. anther
4. chlorophyll
6. adventitious
7. imperfect
8. monocot
11. plumule
12. imbibition
15. pith
16. filament
19. turgid
20. annual
21. stamen

Answers *(continued)*

Letter Maze 3 - page 3-14



QUIZ

True or False - page 3-23

1. true
2. true
3. true
4. true
5. true
6. true
7. true
8. false
9. true
10. false
11. true
12. true
13. true
14. true
15. true

Multiple Choice - page 3-23

16. D
17. A
18. B
19. B
20. A
21. C
22. A
23. C
24. A
25. B

Matching - page 3-24

26. E
27. F
28. A
29. J
30. K
31. D
32. B
33. C
34. H
35. I
36. A anther
    B filament
    C stamen
    D ovule
    E placenta
    F stigma
    G style
    H ovary
    I pistil
    J petal
    K sepal
    L receptacle

GLOSSARY - Chapter 3

adventitious root - a root produced in an unusual place or part of a plant — typically roots produced on above-ground plant parts.

annual - a plant that completes its life cycle in one year.

anther - the male, pollen-producing part of a flower.

asexual reproduction - plant reproduction without the use of seeds.

axillary bud - a bud found in the axil of a leaf.

bark - the exterior tissue or covering of a woody trunk or stem from the cambium outward. Consists mainly of dead tissue.

biennial - a plant which produces leaves the first year of its life. It produces flowers, fruit, and seeds the second year and then dies.

calyx - the external, leafy part of a flower made up of sepals. Usually green, but possesses color in some flowers.

capillary action - the attraction of water molecules to each other disregarding the pull of gravity.

carbohydrate - organic compounds that form the supporting tissues of plants and are important food for animals and people.

chlorophyll - the green pigment in plants which absorbs the energy of sunlight for use in manufacturing sugars from carbon dioxide and water.

chlorosis - lack of chlorophyll development because of disease or, more commonly, nutritional problems such as lack of iron or magnesium.

corolla - the petals of a flower.

cotyledon - the first leaf or leaves in a seed.

cross-pollinated - the contact of pollen from one plant with the stigma of a different plant.

cuticle - the thickened waxy surface layer of certain leaves, fruits and shoots.

dicot (dicotyledon) - a plant that produces seeds which have two cotyledons or seed leaves.

embryo - the part of a seed that grows and develops into a plant upon germination.

endosperm - part of the seed of certain plants that lies alongside the embryo and consists of food materials.

filament - the anther-bearing stalk of a stamen.

footcandle - a unit of light equivalent to the light produced by one candle at a distance of one foot.

guard cell - either of two cells that flank the stomate (pore) and cause it to open and close.

hypocotyl - in the embryo of a plant, the part of the stem below the cotyledons.

imbibition - the absorption of liquid or moisture.

imperfect flower - a flower containing only the staminate (male) or pistillate (female) flower parts, but never both.

meristematic zone - area of embryonic tissue made up of undifferentiated, growing, actively-dividing cells.

mesocotyl - specialized cells located between the scutellum and coleoptile.

Glossary *(continued)*

monocot (monocotyledon) - a plant that produces seeds with a single cotyledon or seed leaf.

node - a joint on a stem where a bud, leaf, or flower stalk is attached.

nutrient - the materials (chemicals) a plant needs in order to grow.

ovary - in a flower, the basal part of the pistil which develops into the fruit.

palisade mesophyll - the layer of cells just beneath the upper surface of the leaf.

pedicel - stem or stalk of a flower.

phloem - meristem cells which conduct food downward. Located in the bark of woody plants next to the cambium.

photoperiod - the time during which a plant is exposed to daylight.

photosynthesis - the manufacture of carbohydrates (food) from carbon dioxide and water in the presence of clorophyll. Uses light energy and releases oxygen.

pistil - the female part of a flower comprised of ovary, stigma, and style.

pith - the spongy supporting tissue in the center of a stem.

placenta - the part of the ovary of flowering plants which bears the ovules

plumule - the primary bud of an embryo or germinating seed plant.

radicle - the lower part of an embryo seedling.

respiration - the process of carbohydrate utilization by a living organism which involves energy release and liberation of water and carbon dioxide.

rhizome - an underground rootlike stem which gives rise to leafy shoots from the upper surface and roots from the lower side.

root hair - a hair-like tubular outgrowth from near the tip of a rootlet that performs the work of absorption.

scutellum - a small plate or shieldlike part of a root.

sexual reproduction - reproduction of plants by seeds as opposed to asexual reproduction by cutting, grafting, etc.

stamen - the reproductive organ of the male pollen-bearing flower.

stigma - the part of the pistil in a flower which receives the pollen grains.

stolon - a stem growing horizontally on or just below the surface of the ground; it usually roots at nodes and produces a new plant.

stomate - a pore or minute hole in the surface of a plant leaf or stem through which gases or water vapor passes.

style - a prolongation of the ovary that supports the stigma in a flower.

transpiration - the emission of water vapor from the aerial parts of a plant chiefly through leaf stomates.

turgid - having adequate moisture in plant cells.

vascular tissue - tissue in which tube or ductlike cells translocate food and water within the plant.

wood - structural cells in the stems of trees and shrubs.

xylem - water-conducting woody tissue in higher plants.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 3

T3-1 *(Student Manual*, page 42)

As roots grow down into the soil, the major branches of the roots become converted into hard, woody material. Thousands of tiny roots and root hairs grow out from lateral areas of these woody roots.

Questions: Through which portions of roots are water and nutrients absorbed? Why is it important to keep the area around newly transplanted trees very moist?

T3-2 *(Student Manual*, pages 43-44)

The **embryo** is the portion of a seed which will become a new plant. The **endosperm** is composed of food which provides energy for the plant to begin growth.

The **scutellum** serves as a food-absorbing organ. It absorbs food from the endosperm and makes it available to the developing embryo. The **coleoptile** is a protective cap over the plumule.

The **plumule** is the tip of the embryo shoot. The **radicle** is the tapering end of the embryo that will develop into the primary root when the seed germinates.

Question: How do the seeds of dicots differ from those of monocots?

T3-3 *(Student Manual*, pages 43-44)

Seed germination is simply defined as "the beginning of seed growth." The process of germination in dicot seeds is different from the germination in monocot seeds.

T3-4 *(Student Manual*, page 45)

In dicots, the radicle is the first portion to emerge from the seed after it absorbs water. The hypocotyl elongates and becomes arched. The arched hypocotyl then pushes through the soil followed by the two cotyledons. The plumule that is located between the two cotyledons sprouts into the first true leaves and stem.

T3-5 *(Student Manual*, pages 46-47)

The **pith** is the centermost zone of a dicot stem. The wood area contains **xylem** and **phloem** tissue. The **bark** zone is a protective area for growing cells. The **cambium** area is where outward growth is taking place.

Questions: What is the function of the pith? Xylem? Phloem?

T3-6 *(Student Manual*, pages 47-48)

Notice where growth actually takes place. Stems on the main branch arise from buds that were there. In sketch 1, the buds are very close together. In 2, there is more distance between them. In 3, the distance is even greater.

Questions: What name is given to the place where a bud arises? What is the space between two buds called?

T3-7 *(Student Manual*, pages 48-49)

In the stem on the top, the entire stem area is filled with cells. The stem on the bottom is hollow and the tissues are located around the stem under the epidermis.

Question: How does this monocot stem structure differ from that of dicots?

T3-8 *(Student Manual*, pages 48-50)

The **meristematic zone** is where cells are dividing. The **zone of elongation** is where cells grow and increase in size. The **zone of maturation** is where growing cells mature.

Questions: Where are the buds formed? In which zone do the xylem and phloem tissues become specialized?

T3-9 *(Student Manual*, page 50)

To summarize briefly, dicots and monocots differ in some ways. However, in other ways they are similar.

Questions: What are some of the basic differences between monocots and dicots? In what ways are they similar?

T3-10 *(Student Manual*, page 50)

This table summarizes the differences between monocots and dicots.

Question: Why is it important for nursery operators to know the difference between monocots and dicots?

T3-11 *(Student Manual*, pages 51-52)

Because of photosynthesis, plants increase in size and produce fruit. Another important function of photosynthesis is the production of oxygen. This figure illustrates how photosynthesis takes place in plants.

Question: Why is it important for nursery workers to understand the process of photosynthesis?

T3-12 *(Student Manual*, pages 51-53)

The results of photosynthesis are the production of glucose (sugar) and oxygen which is released into the air. In most plants glucose is changed to starch for storage.

T3-13 *(Student Manual*, pages 51-53)

This drawing represents the reaction that takes place in each leaf cell. Each cell is shown as a factory within itself.

T3-14 *(Student Manual*, pages 51-54)

Stomates are small openings, usually located on the underside of leaves. They are formed by two specialized cells called **guard cells.**

Questions: What happens when these guard cells are open? Closed?

T3-15 *(Student Manual*, pages 59-60)

There are several theories as to just how water moves upward in plants. These drawings illustrate the **cohesion theory**. As water is lost in the leaves through transpiration, the concentration of actual water in the leaf cells is lowered. Water in adjacent cells moves into this area of lower concentration. Now these cells that just contributed water are lower in their own water concentration. The next cells lower in the branch or stem then contribute water to them, and so on.

T3-16 *(Student Manual*, pages 59–60)

Active absorption accounts for only a very small amount of the water absorbed by plants. It is essentially the same process as cohesion. Passive absorption depends upon the forces of pressure.

T3-17 *(Student Manual*, pages 60–64)

This figure illustrates the various parts of a typical flower.

Questions: Which are the male parts of this flower? Female? Where does the actual pollination take place?

T3-18 *(Student Manual*, pages 61–64)

The female part of the flower is called the **pistil**. It is made up of three parts: stigma, style, and ovary.

Question: After fertilization takes place, where do cell division and embryo development take place?

T3-19 *(Student Manual*, pages 60–64)

This figure illustrates the reproductive cycle in plants. The cycle is continuous. The plant grows and, upon reaching maturity, produces flowers that become fertilized. Then the cycle begins again.

Question: How do annuals, biennials and perennials differ?

T3-20 *(Student Manual*, pages 61–64)

If a flower can be pollinated by its own pollen, the plant is **self-pollinated**. If a flower requires pollen from another plant, it is **cross-pollinated.**

Question: How does pollen get from one flower to another in cross-pollination?

T3-21 *(Student Manual*, pages 61–64)

Corn is somewhat different from a typical nursery plant. The male part is located at the top of the plant. The female part is located on the stalk and is known as the ear. Hairs that stick out of the end of the end of the corn ear are attached to silks (which are actually styles).

There is one silk for each possible kernel that can be produced on an ear of corn. A pollen grain must land on each of these silk hairs before a kernel of corn can be produced at that spot on the ear.

T3-22 *(Student Manual*, page 65)

A rhizome is an underground stem. Nodes are located at intervals along these stems. Axillary buds and roots form at these nodes. Eventually these new plants become self-supporting.

Questions: What are some of the more common plants which have rhizomes? Are these plants annuals or perennials?

T3-23 *(Student Manual*, page 65)

Stolons are aerial (above-ground) stems. At the points where the stolons touch ground, they send up shoots (new leaves) and form a root system of their own.

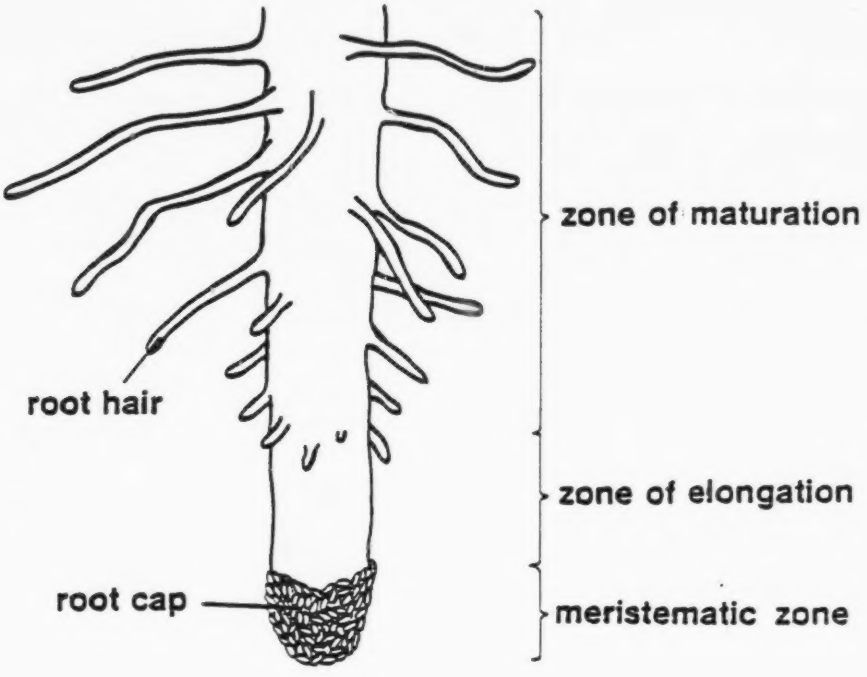
Question: What are some of the more common plants which have stolons?

T3-24 *(Student Manual*, pages 65-66)

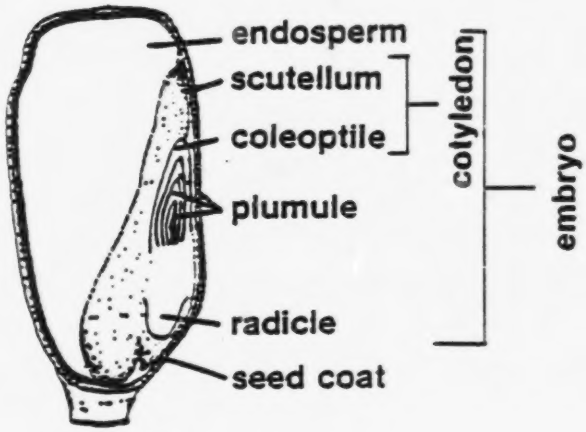
Some plants, such as the white potato, are propagated only vegetatively. The white potato is an enlarged, swollen tip of a stolon. The potato "eyes" are capable of developing into shoots. Each shoot, in turn, produces its own root system.

Question: What are some other types of plants which develop tubers?

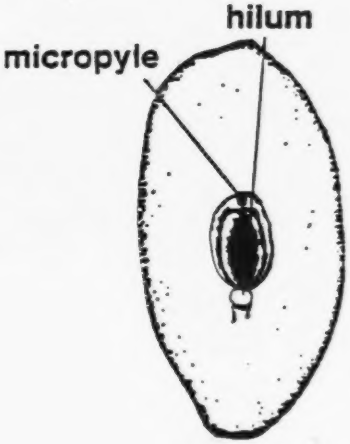
Enlarged Section of a Root


zone of maturation
root hair
zone of elongation
root cap
meristematic zone

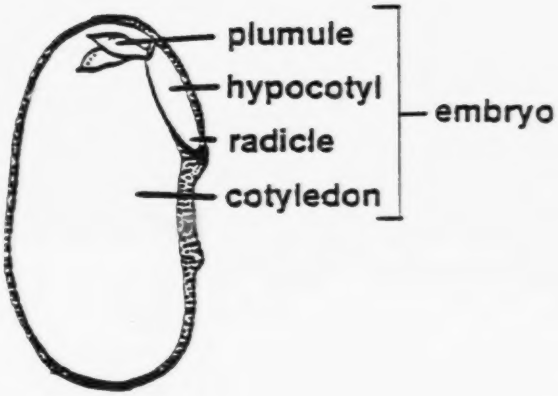
Views of Corn and Bean Seeds


endosperm
scutellum
coleoptile
cotyledon
plumule
embryo
radicle
seed coat

CORN

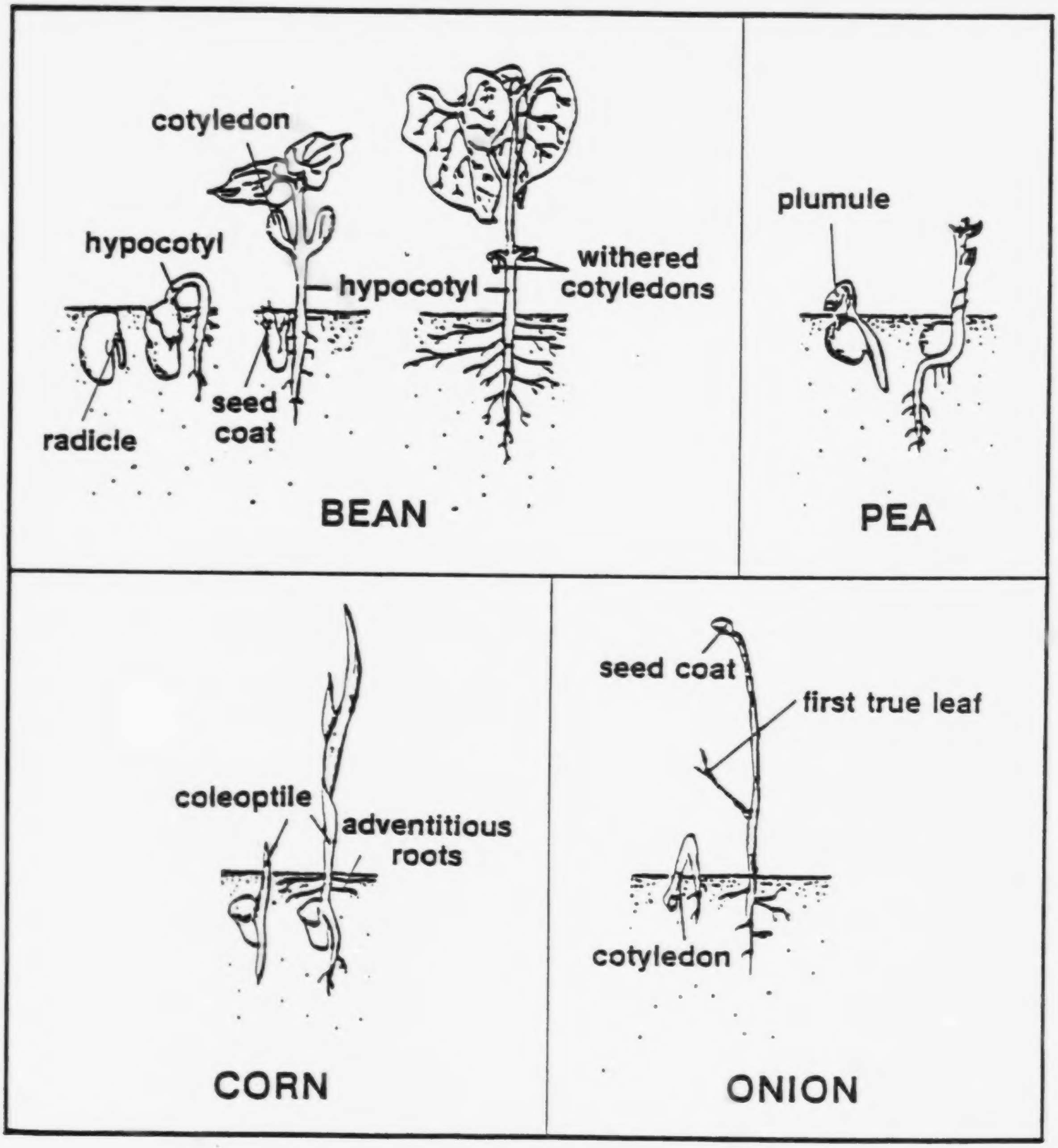

hilum
micropyle

BEAN

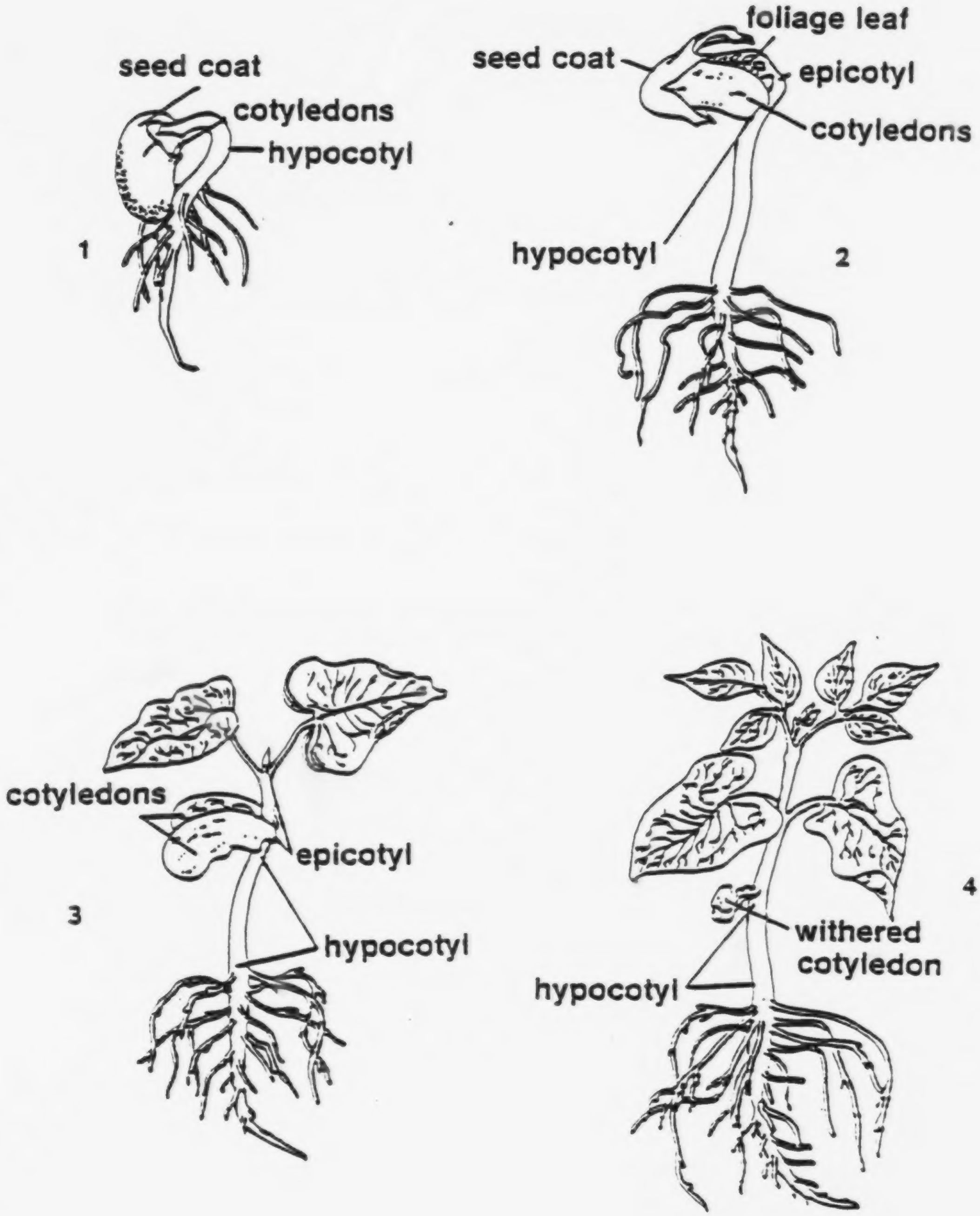

plumule
hypocotyl
radicle
cotyledon
embryo

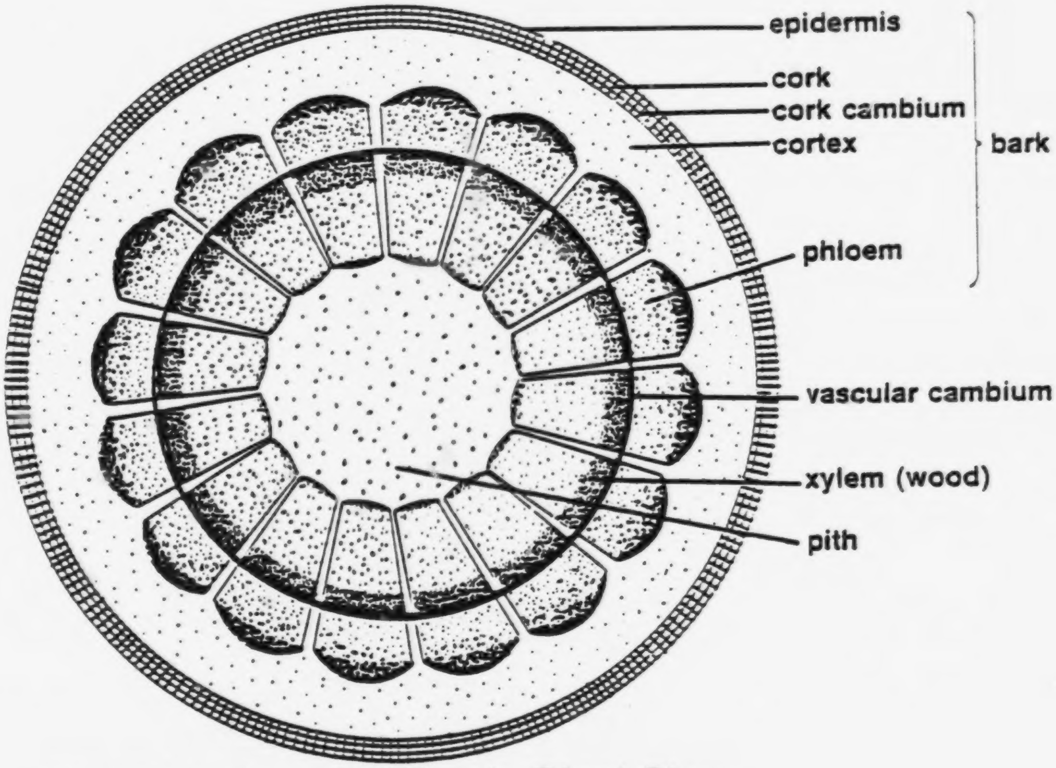
BEAN

Comparison of Germination Stages in Some Dicots and Monocots

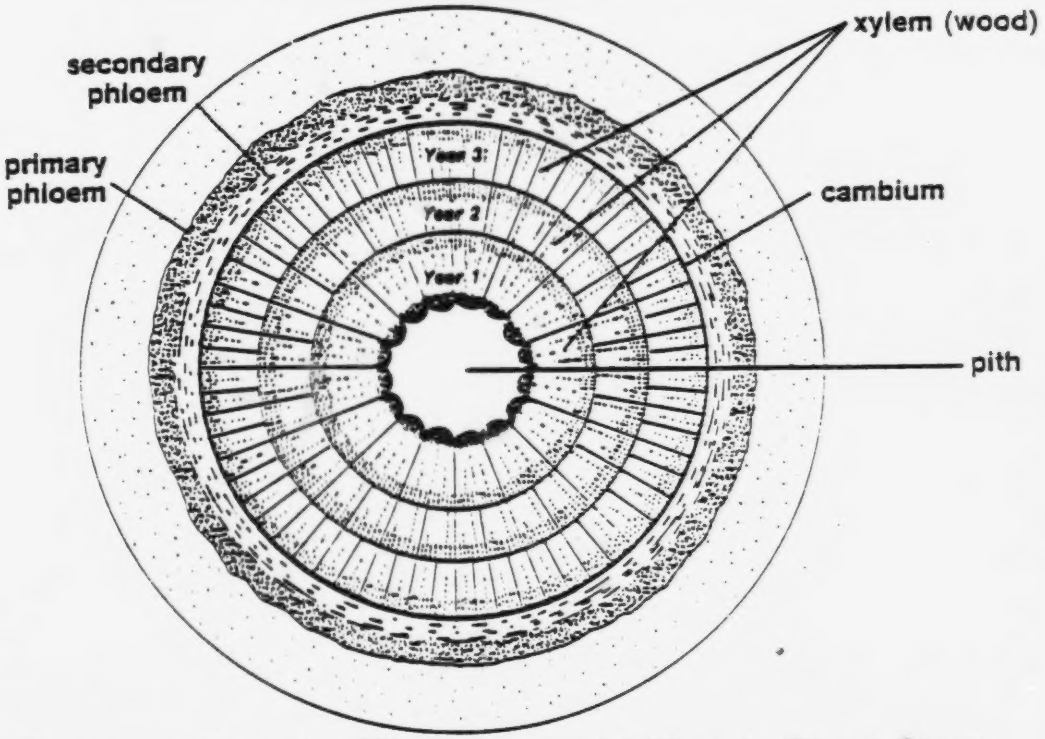

cotyledon
hypocotyl
hypocotyl
withered cotyledons
radicle
seed coat
BEAN
plumule
PEA
coleoptile
adventitious roots
CORN
seed coat
first true leaf
cotyledon
ONION

Development of a Germinating Dicot (Bean) Seed


seed coat
cotyledons
hypocotyl
1
foliage leaf
seed coat
epicotyl
cotyledons
hypocotyl
2
cotyledons
epicotyl
3
hypocotyl
4
withered cotyledon
hypocotyl

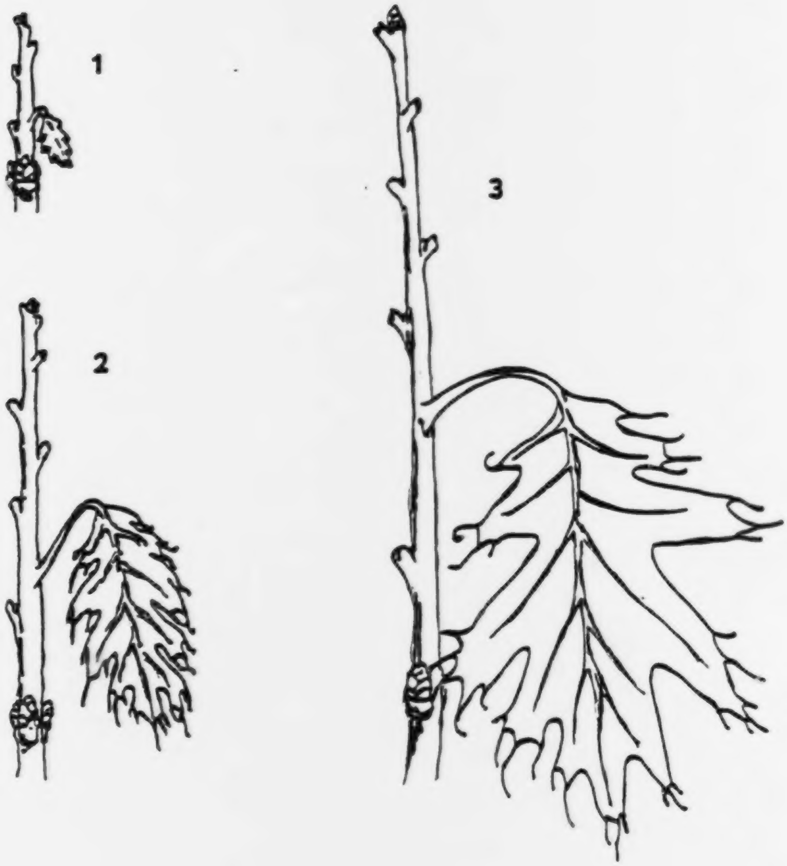

epidermis
cork
cork cambium
cortex
bark
phloem
vascular cambium
xylem (wood)
pith

Cross-section of a Woody Dicot Stem

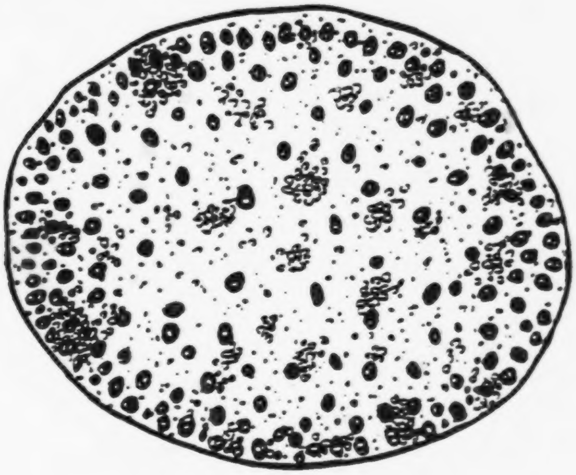

xylem (wood)
secondary phloem
primary phloem
Year 3
Year 2
Year 1
cambium
pith

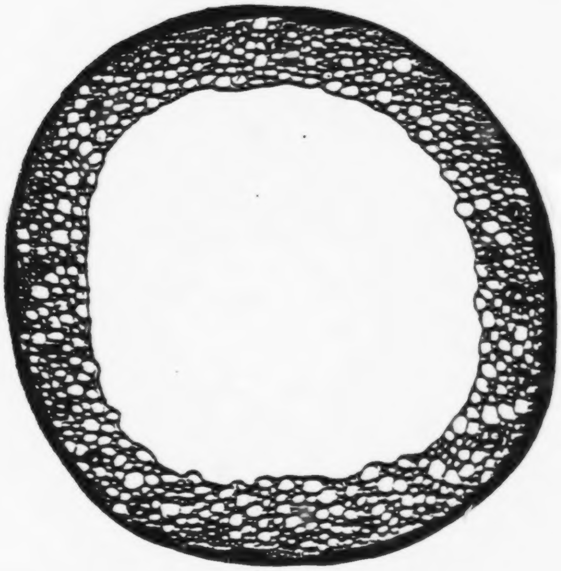
Cross-section of a Three-year-old Woody Dicot Stem

Stages in Growth of a Dicot Stem

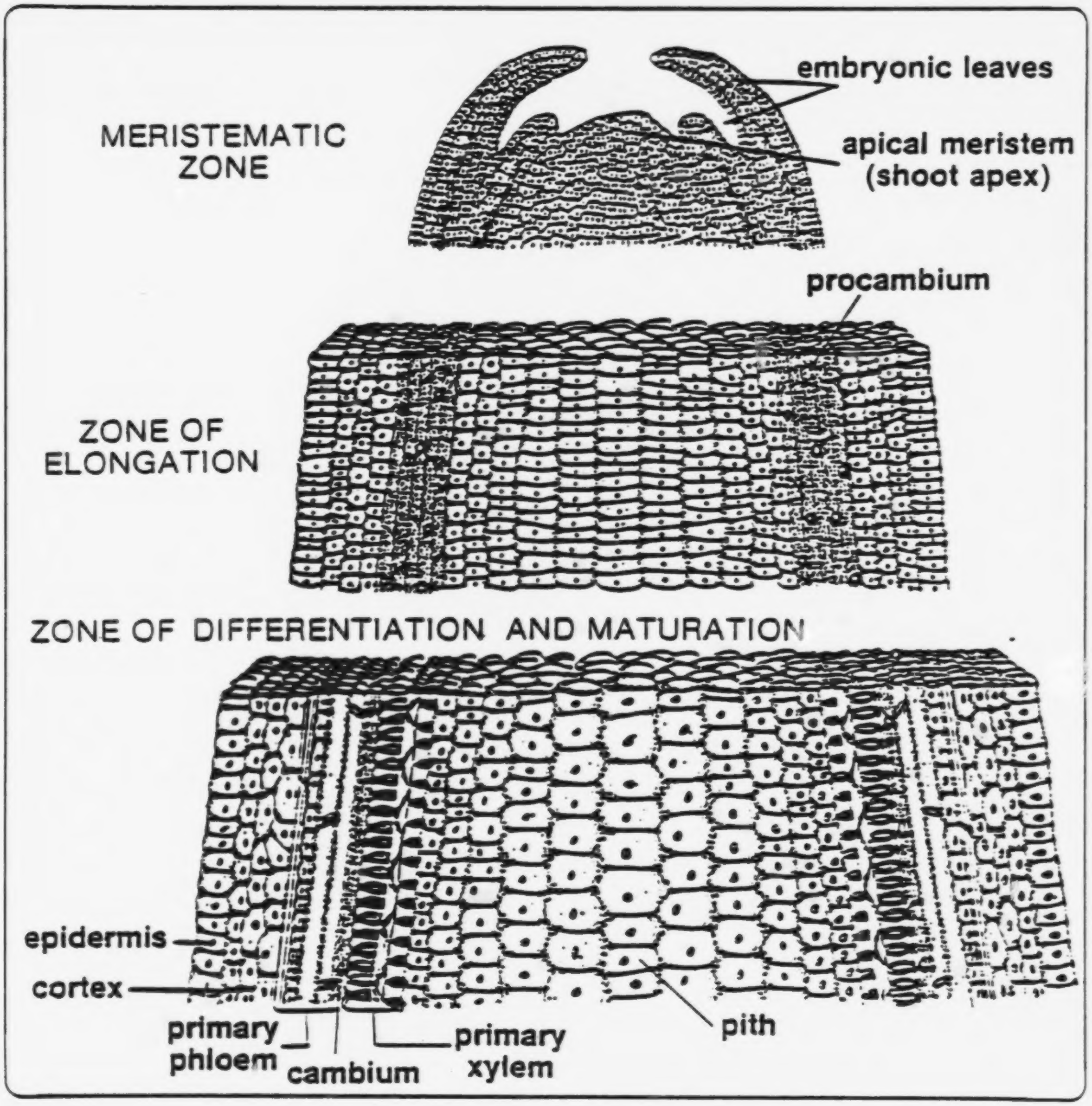


Cross-sections of Two Types of Monocot Stems



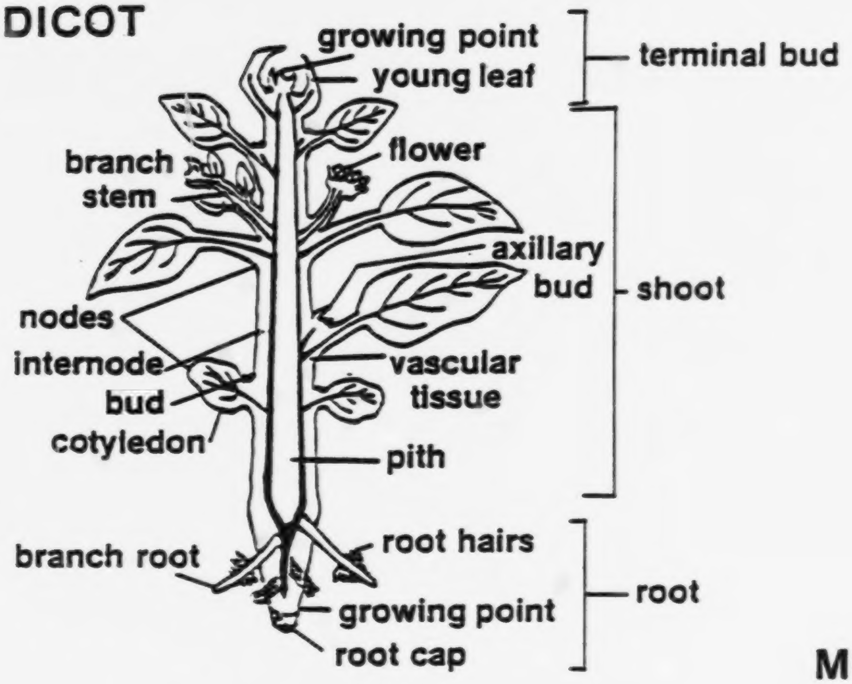


Enlarged View of Section of a Growing Stem Showing the Three Major Zones

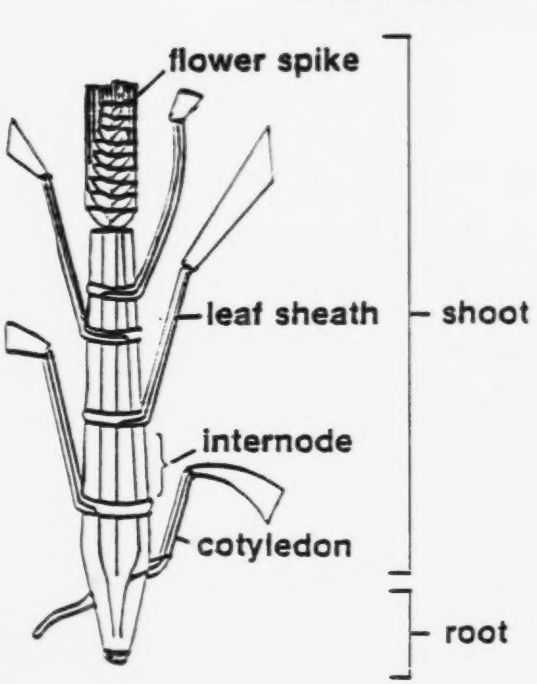

MERISTEMATIC ZONE
embryonic leaves
apical meristem (shoot apex)
procambium
ZONE OF ELONGATION
ZONE OF DIFFERENTIATION AND MATURATION
epidermis
cortex
primary phloem
cambium
primary xylem
pith

Leaf and Stem Development in Monocots and Dicots

DICOT

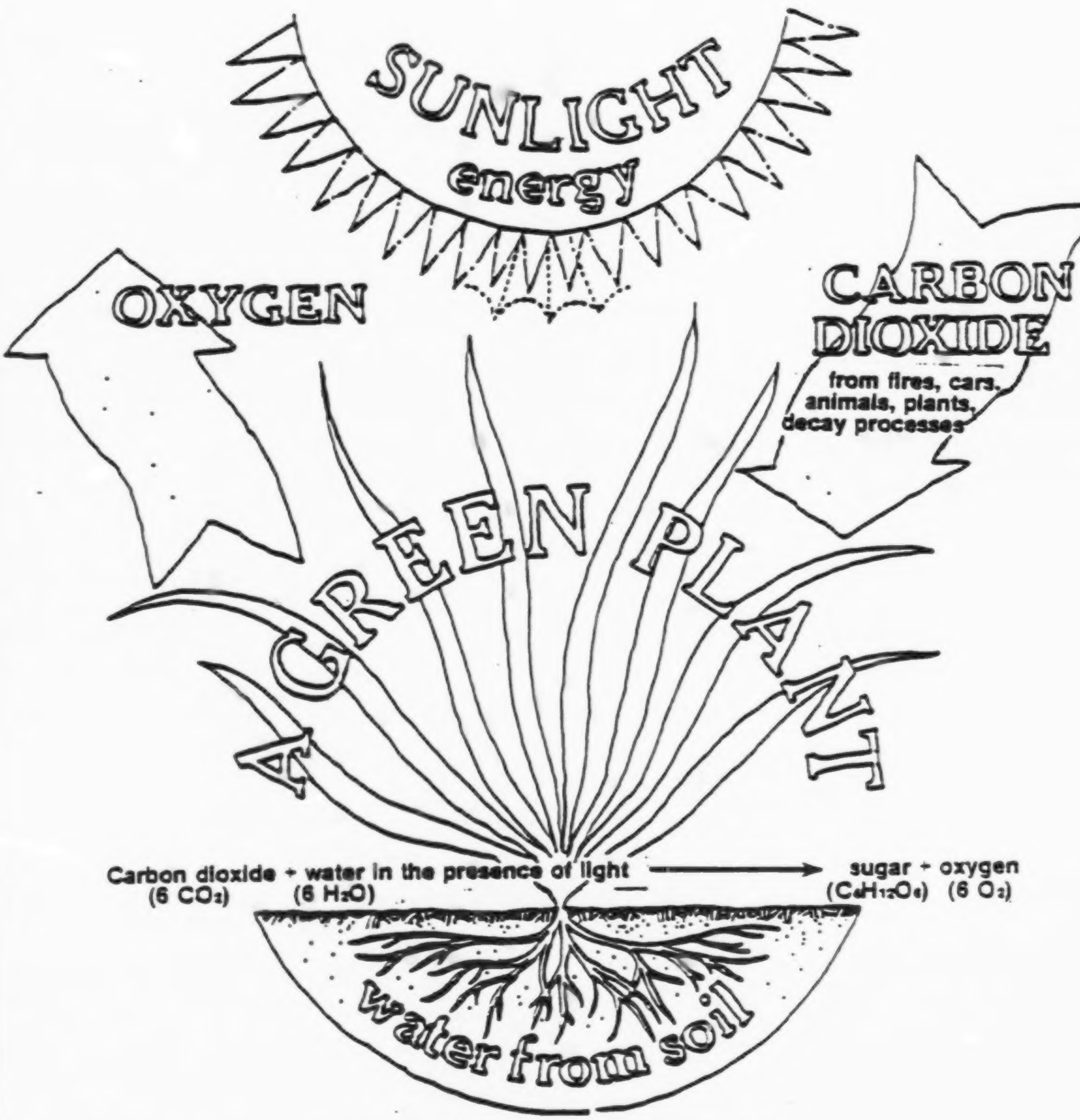

growing point
young leaf
terminal bud
flower
branch
stem
axillary bud
shoot
nodes
internode
vascular tissue
bud
cotyledon
pith
root hairs
branch root
root
growing point
root cap

MONOCOT


flower spike
leaf sheath
shoot
internode
cotyledon
root

Summary of Differences Between Monocots and Dicots

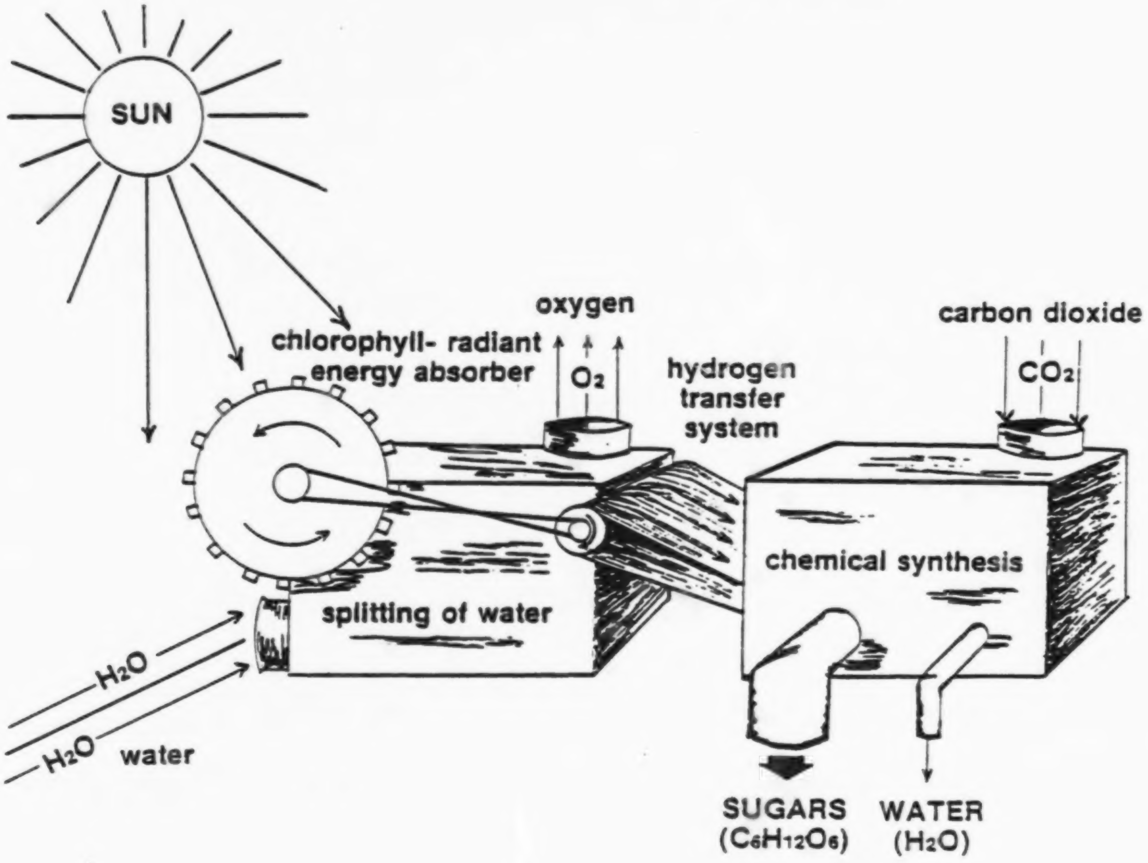
	MONOCOTS	DICOTS
Seed and Seed Germination	• one seed leaf per seed • stored food of seed in endosperm	• two seed leaves per seed • stored food of seed in cotyledons
Roots	• fibrous root system	• often much-branched, well-developed tap root system
Stems	• underground stems often form bulbs, rhizomes, etc. • no cambium in mature stems	• cambium present in mature stems
Leaves	• usually simple with parallel veins	• large assortment of leaf shapes with radiating or netted veins
Flowers	• flower petals and sepals often identical • flower parts in multiples of 3	• flower petals and sepals usually different • flower parts in 4's and 5's


SUNLIGHT
energy
OXYGEN
CARBON DIOXIDE
from fires, cars, animals, plants, decay processes
A GREEN PLANT
Carbon dioxide + water in the presence of light → sugar + oxygen
(6 CO_2) (6 H_2O) ($C_6H_{12}O_6$) (6 O_2)
water from soil

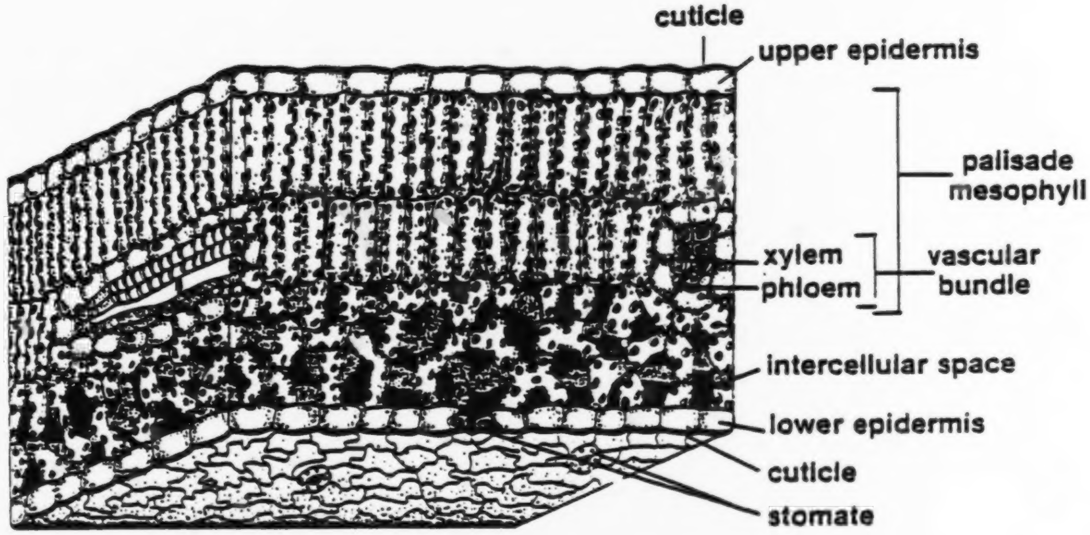
PHOTOSYNTHESIS

. . . the most extensive chemical process on earth, and the only source of oxygen in the atmosphere

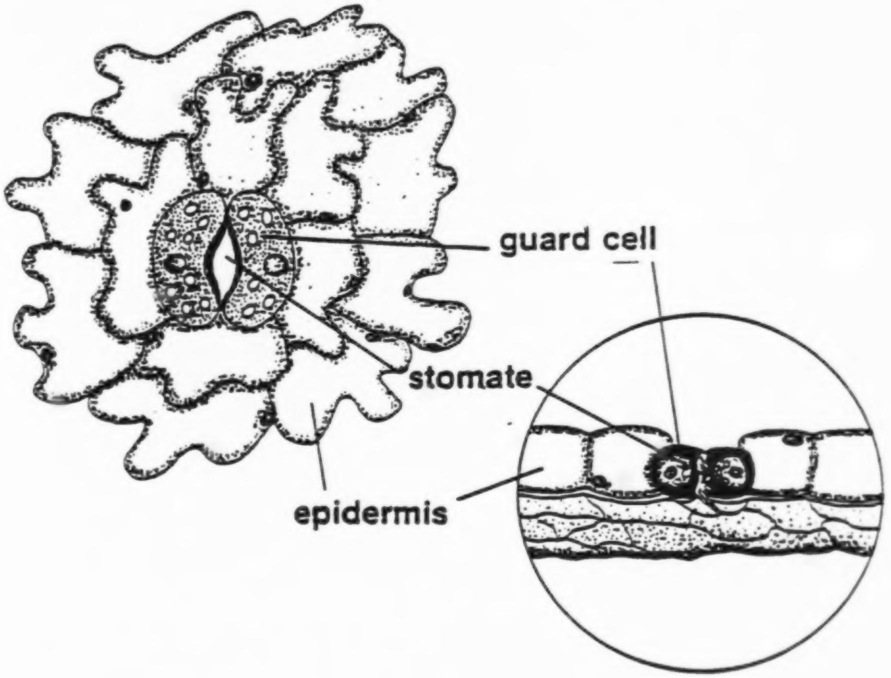
A "Photosynthesis Machine"


SUN
oxygen
carbon dioxide
chlorophyll- radiant energy absorber
O_2
hydrogen transfer system
CO_2
chemical synthesis
splitting of water
H_2O
H_2O
water
SUGARS ($C_6H_{12}O_6$)
WATER (H_2O)

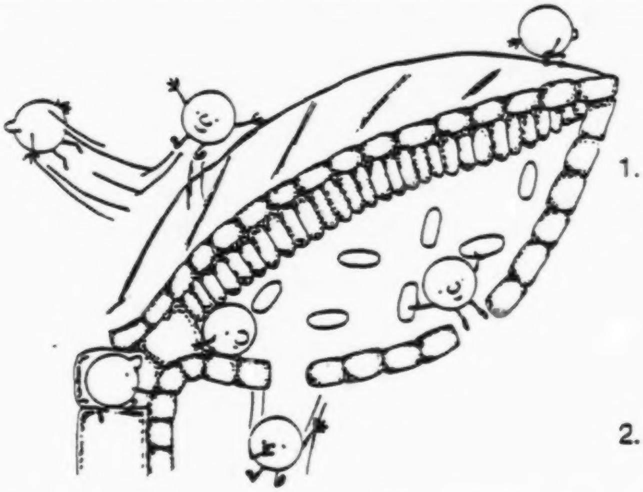
Enlarged Drawing of a Leaf Section


cuticle
upper epidermis
palisade mesophyll
xylem
phloem
vascular bundle
intercellular space
lower epidermis
cuticle
stomate

Enlarged Drawing of a Stomate

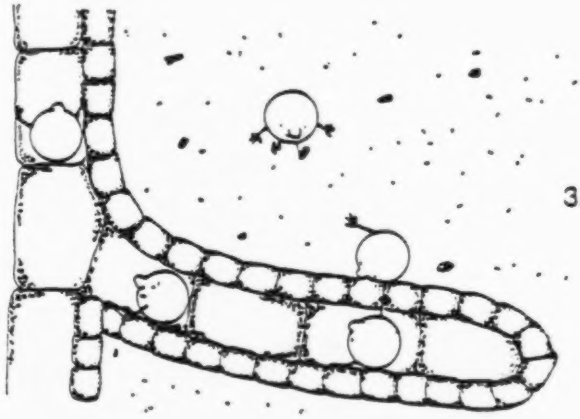

guard cell
stomate
epidermis

Water Movement Upward in a Plant



1. Transpiration occurs. Water moves out of leaf.

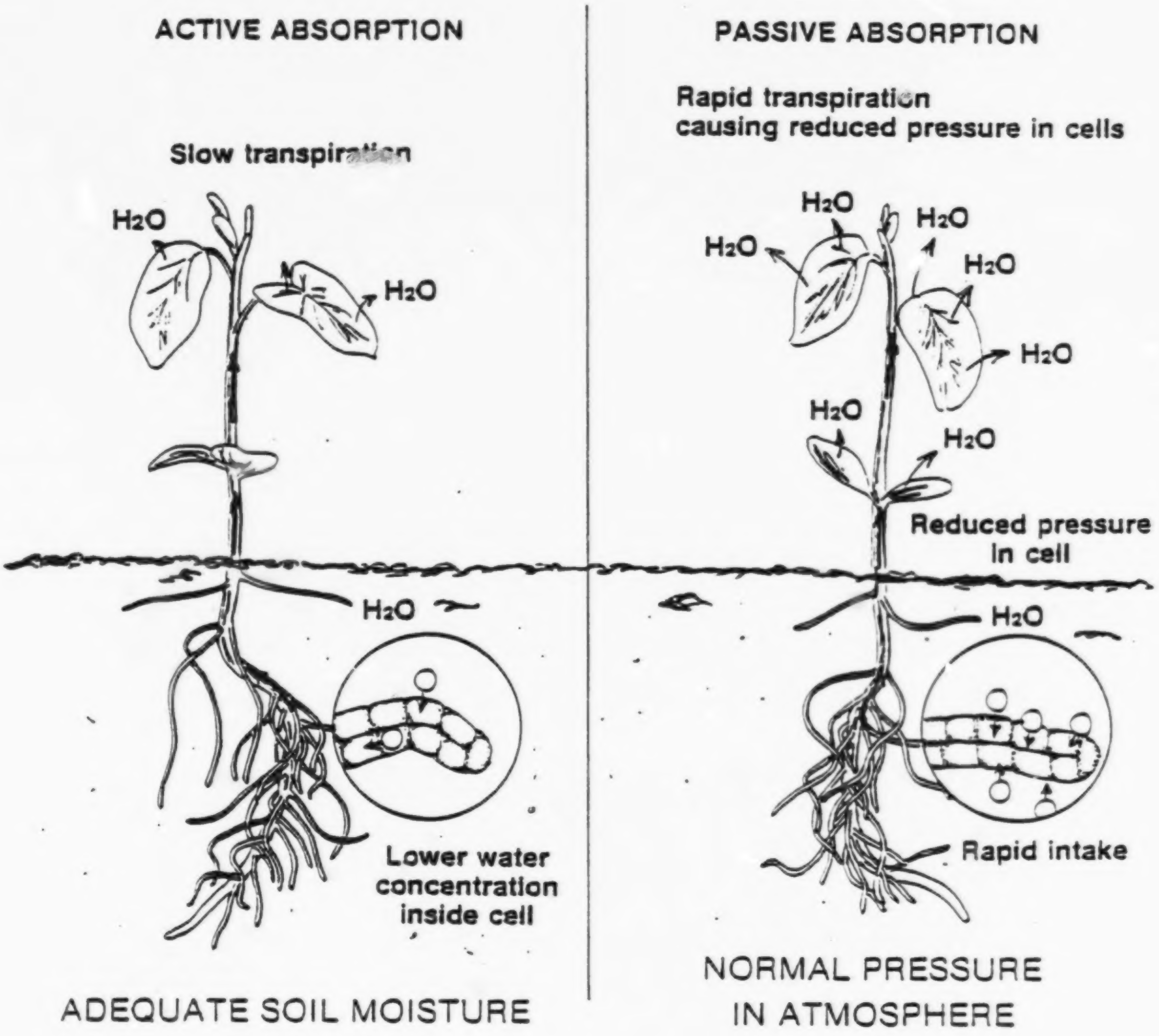
2. Water from adjoining cell enters area of lower water concentration.



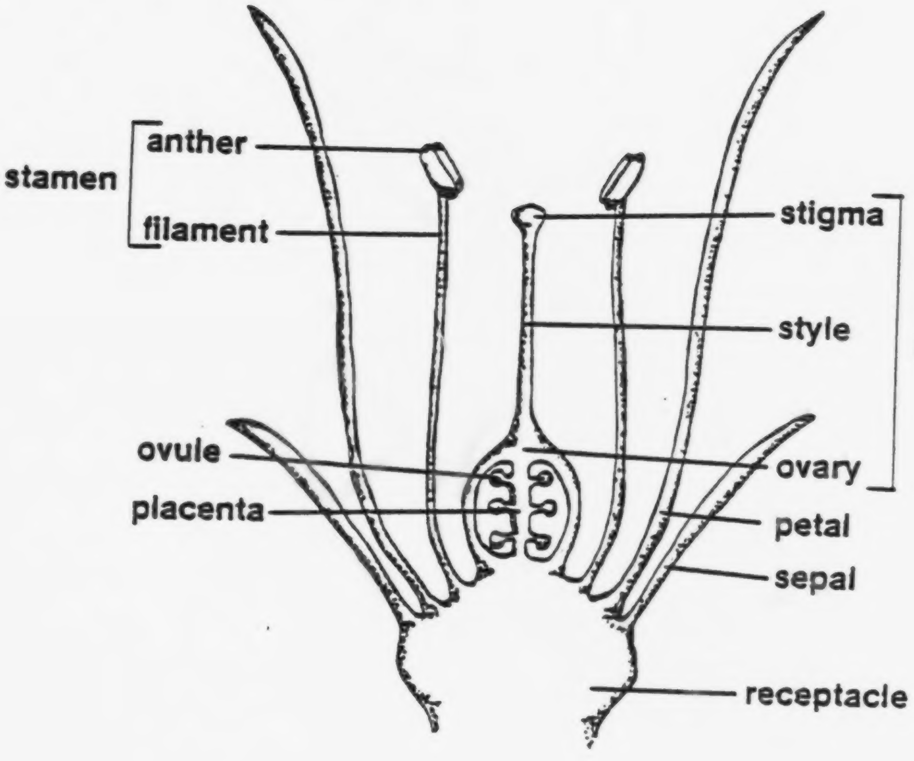
root in soil

3. Cell by cell the water moves up.

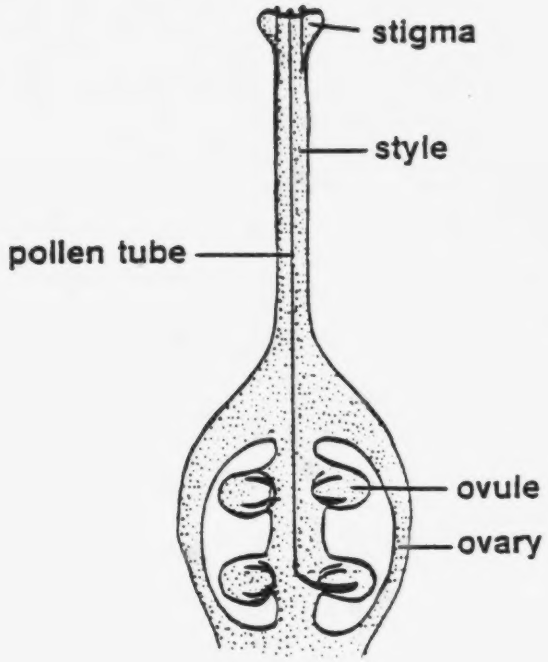
Contrast of Water Movement in Active and Passive Absorption


ACTIVE ABSORPTION
Slow transpiration
H_2O
H_2O
H_2O
Lower water concentration inside cell
ADEQUATE SOIL MOISTURE
PASSIVE ABSORPTION
Rapid transpiration causing reduced pressure in cells
H_2O
H_2O
H_2O
H_2O
H_2O
H_2O
H_2O
Reduced pressure in cell
H_2O
Rapid intake
NORMAL PRESSURE IN ATMOSPHERE

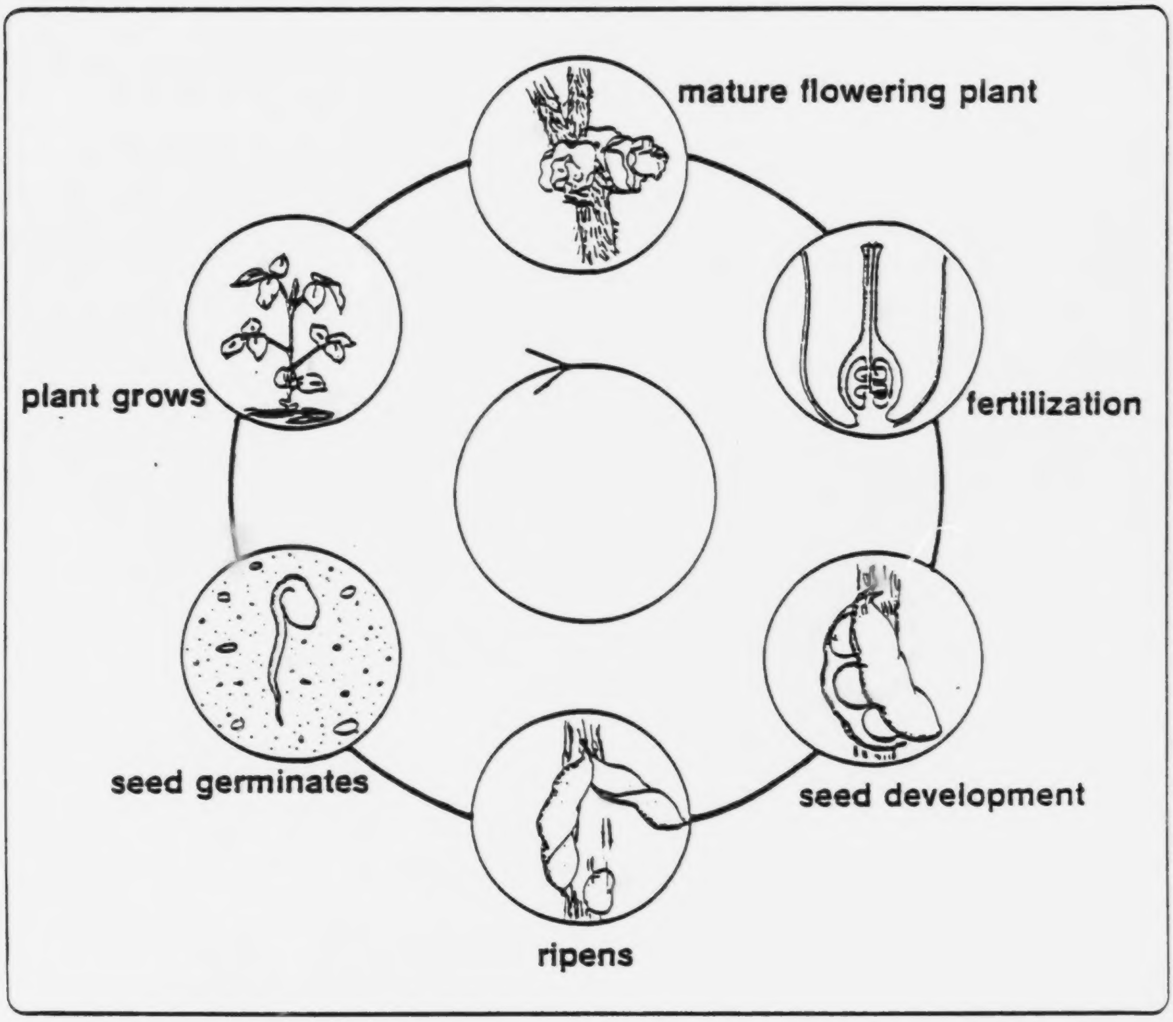
Parts of a Flower


stamen
anther
filament
stigma
style
pistil
ovule
placenta
ovary
petal
sepal
receptacle

Female Flower Parts Showing Growth of Pollen Tubes after Pollination


stigma
style
pollen tube
ovule
ovary

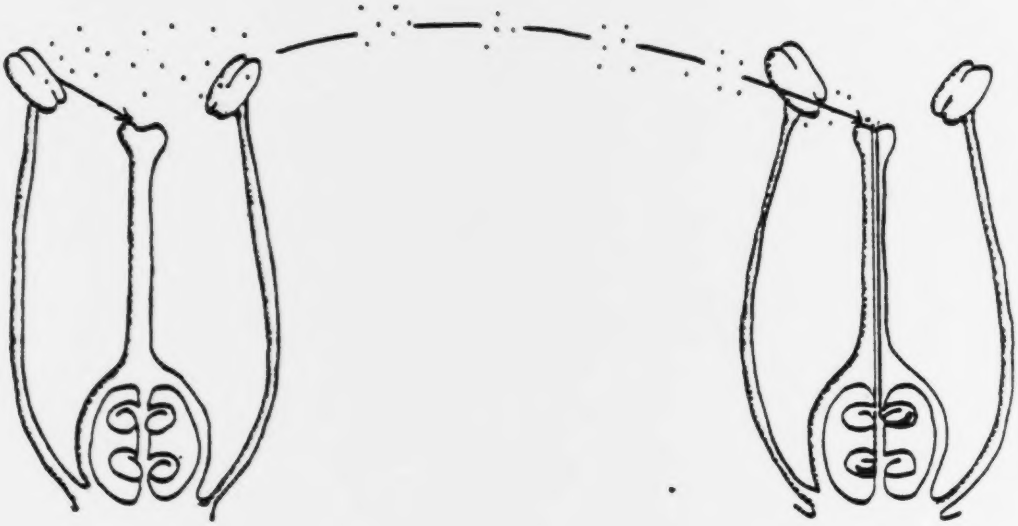
Reproductive Cycle in Plants


mature flowering plant
fertilization
seed development
ripens
seed germinates
plant grows

153

Self-Pollination

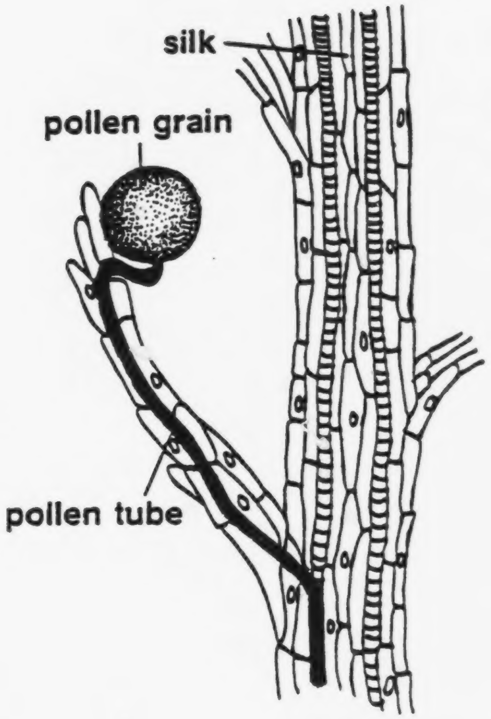
Cross-Pollination



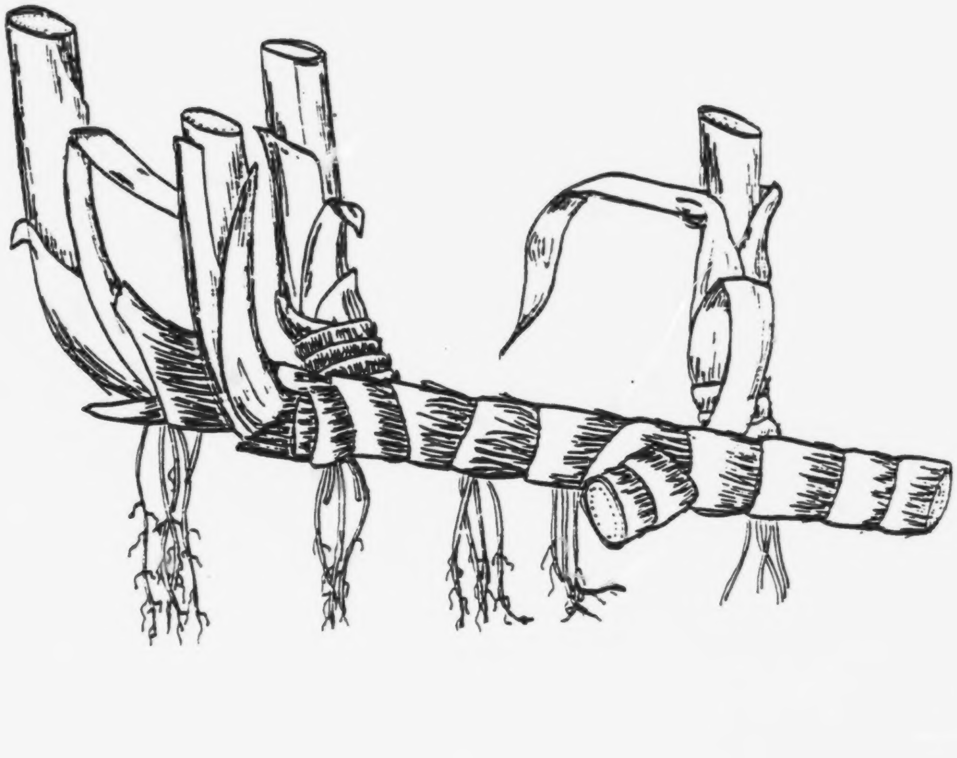
No Seed Formed

Fertilization and Seed Formation

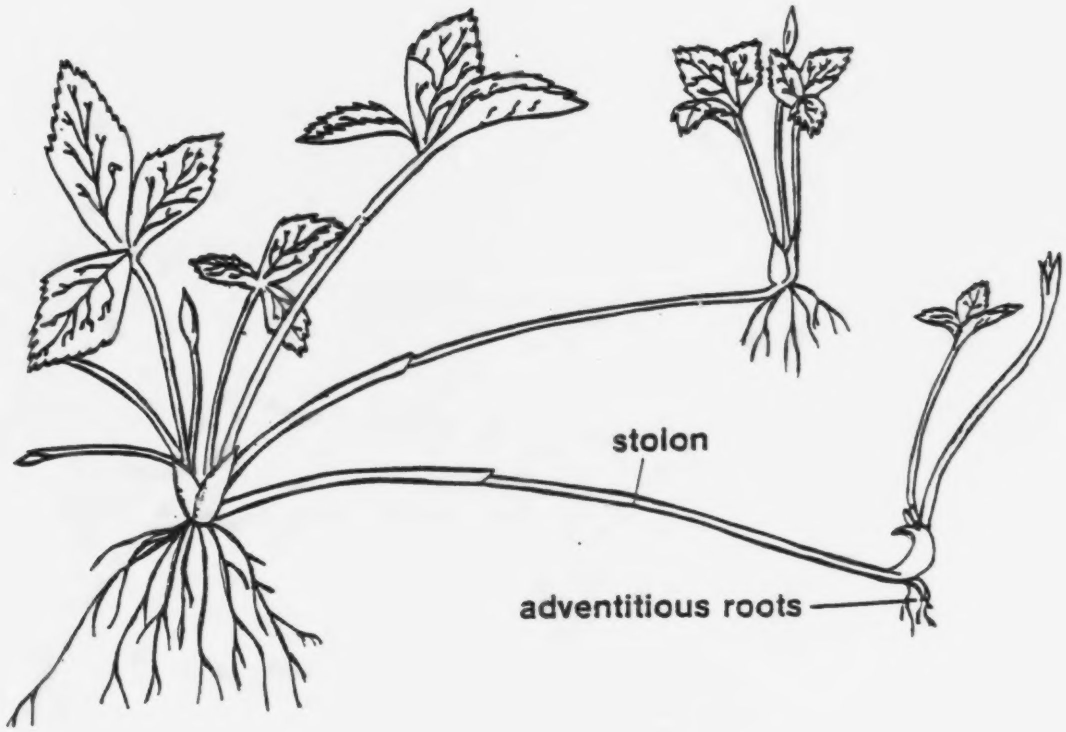
Pollen Grains on a Corn Silk


silk
pollen grain
pollen tube

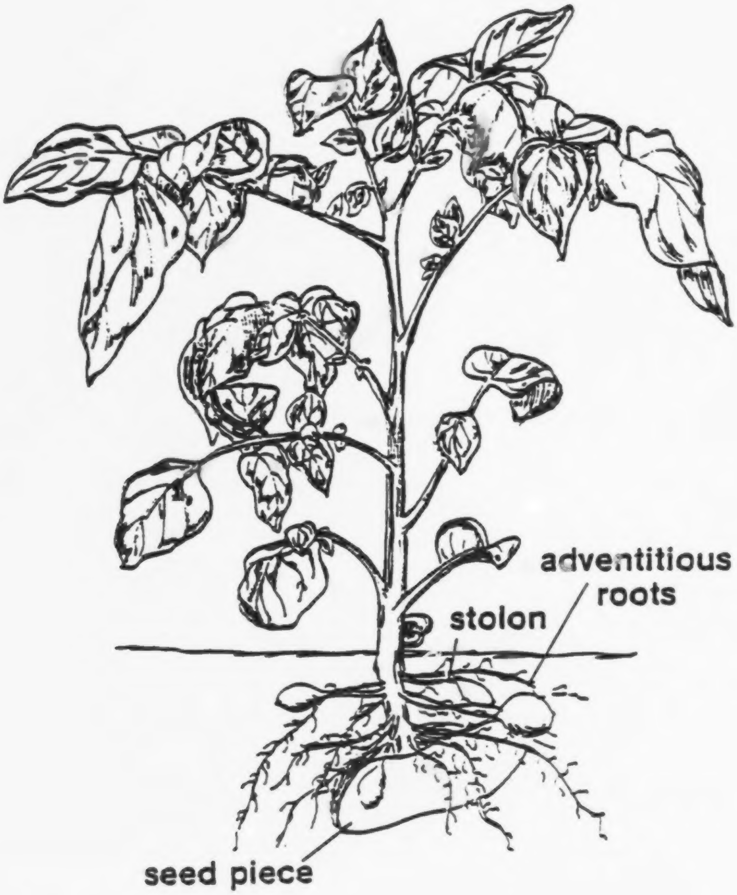
Asexual Reproduction through Rhizomes



Asexual Reproduction through Stolons


stolon
adventitious roots

Asexual Reproduction through Tubers


adventitious
roots
stolon
seed piece

CHAPTER 4

PLANT NUTRITION

PERFORMANCE CHECK LIST

1. List the macronutrients required by plants to grow properly.
2. List the micronutrients required by plants to grow properly.
3. Demonstrate the effects of nutrient deficiencies in plants.
4. Explain the procedure by which nutrient ions are attracted to and held on soil particles.
5. Describe the three theories regarding nutrient entry into plants.
6. Differentiate between complete and incomplete fertilizers.
7. Determine approximately the amount of fertilizer used in your home county for the previous year.
8. Demonstrate the process of soil testing.
9. Demonstrate the ability to obtain a representative soil sample.
10. Demonstrate the ability to fill out the **soil information sheet** which accompanies the soil sample.
11. Demonstrate the ability to interpret soil test results and recommendations for nursery crops.
12. Demonstrate the ability to determine the amount and ratios of commercial fertilizer needed to obtain the recommendations.
13. Demonstrate the ability to interpret soil test results and recommendations for turfgrass and nursery stock.
14. Explain the relationship of plant analysis to soil tests.
15. Demonstrate the ability to interpret a plant analysis report.

SUGGESTED LEARNING ACTIVITIES

1. Have students collect soil samples from various local nurseries. Test soils and compare the differences and similarities.
2. Develop test pots of plants grown in pure sand. Apply and/or withhold various macronutrients and micronutrients and observe what happens to the plants. Check daily and record your observations. Match the symptoms with the appropriate nutrient deficiencies and/or excesses.
3. Have students survey local nurseries and landscaping firms to develop a list of the various complete and incomplete fertilizers used by local horticultural businesses.
4. Have students take a representative soil sample from an area such as a garden plot, nursery or lawn and prepare the sample for testing in a soil laboratory.
5. Have students compare the amount of nutrients available in a complete fertilizer with the amount available in an organic fertilizer.
6. Have students use a soil testing kit to analyze a soil sample of their choosing, such as from their garden or lawn. Soil test results should be turned in to the teacher.
7. Require all students to take a soil sample of their lawn, garden crop or other area. Send in these samples to the state soil testing laboratory and analyze results. Build costs of this sampling into student fees.
8. Have students collect soil samples of school land lab. Send these samples to the state soil lab for analysis. Use a soil test kit to analyze similar soil samples. Compare soil test kit results with those of the state lab.
9. Demonstrate the effects of fertilizers or lack of fertilizers on plants. Set up control groups (without fertilizer) and groups which receive various amounts of fertilizer.
10. Visit a local fertilizer dealer. See how fertilizer is transported, stored, mixed, proportioned, etc.
11. Have students select the proper analysis fertilizer based on the results of a soil test. Then apply this fertilizer to a lawn or nursery growing area.
12. Fertilize container grown nursery stock with tablet-type fertilizer.
13. Grow several plants withholding nutrients. Send your state lab a plant sample for foliar analysis. Then resume normal feeding and again evaluate the results.
14. With a soil test kit have each student take a soil sample of the school farm, lawn, land lab, etc. Compare the various results.
15. Run an experiment with a greenhouse crop *over-* and *under-*fertilizing with several of the macronutrients.
16. Dissolve NaCl in a glass of water to demonstrate ionization. Note the level of water. Ions fill holes between water molecules.
17. Have students break into groups. Have each group locate a landscape maintenance firm in his or her area. Contact a representative of that firm and ask questions about the type of fertilizers they apply on turf, trees, etc. Students should report this information to the class and compare the answers of various groups.
18. Contact a local representative of a turf maintenance firm and arrange to have a guest speaker give a short presentation and discussion of the types of fertilizers applied in the home market.
19. Take a stalk of celery with leaves attached or a white carnation and place in a colored water solution to observe the change in color of the leaf or flower. Discuss why this change occurs.

SAMPLE INTEREST APPROACH

What would happen if you didn't eat any food at all? Would you die slowly or quickly? What would some of your symptoms of starvation be?

What would happen if you did not eat properly? For example, what kind of symptoms might develop if you ate nothing but chocolate candy bars? What if you ate nothing but steak? What if all you ate was lettuce?

What happens to plants that don't get enough to "eat" (i.e. enough fertilizer)? What are their symptoms? What about plants that get nothing to "eat"? Do they die quickly or slowly?

What happens to plants that are fed a poor diet? For example, suppose nitrogen was like a chocolate candy bar for plants. What would happen to a plant that "ate" nothing but nitrogen? What are some likely symptoms? What about a plant that received only phosphorus?

NAME ____________________

KEY QUESTIONS FOR CHAPTER 4

PART 1

Macronutrients/Micronutrients

1. What is the difference between a macronutrient and a micronutrient? (pages 67-68)

2. How many elements are considered macronutrients for plants? (page 67) ____________

3. What is the function of nitrogen in plants? (page 68)

4. How do microorganisms react to nitrogen in soils? (page 68)

5. What is the function of phosphorus in plants? (page 68)

6. Why isn't much of the phosphorus in soils available to plants? (page 68)

7. What is the function of potassium in plants? (page 68)

8. What is the function of sulfur in plants? (page 68)

9. What is the function of calcium in plants? (page 68)

10. What is the function of magnesium in plants? (page 68)

(continued)

Key Questions *(continued)*

11. List 7 micronutrients needed by plants. (pages 68-69)

12. How does an alkaline soil condition affect iron uptake by plants? (page 68)

NAME ____________________

PART 2

Nutrient Entry into Plants

1. How do plants take up nutrients from the soil? (pages 70-72)

2. What is a differentially permeable membrane? (page 71)

3. Differentiate among the "Ion Exchange Theory," the "Carrier Theory," and the "Mass Flow Theory" for nutrient entry into plants. (pages 71-72)

Fertilizers

4. What is a complete fertilizer? (page 74)

5. What is an incomplete fertilizer? (page 74)

6. What is a fertilizer "grade"? (page 74)

NAME ______________________

PART 3

Soil Testing and Plant Analysis

1. Why are soils tested? (page 75)

2. Why is it desirable to have a composite soil sample? (page 76)

3. Briefly describe the 6 steps in processing a soil sample. (page 77)

4. What is plant analysis? (page 80)

5. What do the results of plant analysis tell you? (page 80)

NAME ______________________

TERMS TO REMEMBER

Chapter 4

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 4 of *The Nursery Worker.*

Technical Vocabulary

complete fertilizer
differentially permeable membranes
dolomite
endodermis
incomplete fertilizer
iron chlorosis
macronutrients
micronutrients
microorganism
nutrient
phloem
plant analysis

______________________ 1. Meristem cells, located in the bark of woody plants next to the cambium, that conduct manufactured food downward. (page 46)

______________________ 2. A specialized tissue in the roots and stems of vascular plants. (page 71)

______________________ 3. A fertilizer containing nitrogen, phosphorus, and potassium. (page 74)

______________________ 4. A mineral (calcium magnesium carbonate) used to raise pH. (page 68)

______________________ 5. Membranes which, to different degrees, allow the passing of solution through them. (page 71)

______________________ 6. A fertilizer containing only one or two of the three major nutrients. (page 74)

______________________ 7. Testing plant material to determine the presence and amount of nutrients actually in the plant. (page 80)

______________________ 8. Symptoms resulting from a plant's reaction to the conditions in an alkaline soil when iron becomes insoluble and unavailable. (page 68)

______________________ 9. One of the substances which a plant synthesizes into food. (page 67)

______________________ 10. Chemical elements which are essential to the growth of plants, but are required only in very small amounts. (page 68)

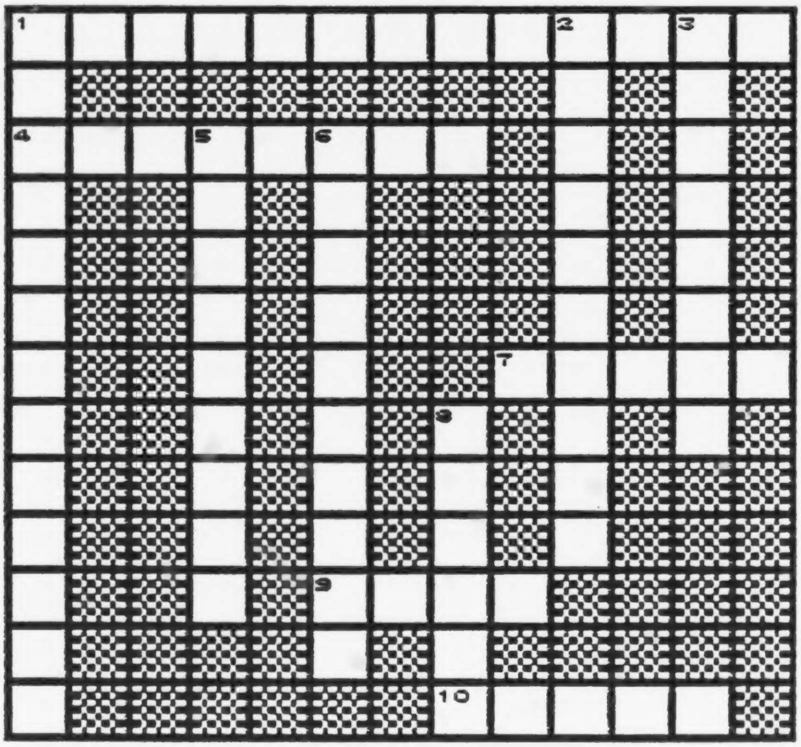
______________________ 11. Chemical elements which are required in considerable abundance for the growth and survival of plants. (page 67)

______________________ 12. A microscopic plant or animal. (page 68)

NAME ____________________

CROSSWORD PUZZLE 4

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker*.



ACROSS Clues

1. An element essential to plant growth, but needed only in small amounts. (page 68)
4. A ________ fertilizer contains nitrogen, phosphorus and potassium. (page 74)
7. A tree, shrub, or herb. (glossary)
9. Chlorosis in plants is often caused by a lack of ________. (page 68)
10. A ________ organism is a tiny plant or animal, often too small to be seen without a microscope. (page 68)

DOWN Clues

1. An element needed by plants in large quantities. (page 67)
2. 0-60-0 is an example of an ________ fertilizer. (page 74)
3. A general term referring to one of the sixteen elements needed by plants. (page 67)
5. A term used to describe a cell wall which permits the passage of gas or water either in or out. (page 71)
6. A specialized tissue in the roots and stems of vascular plants. (page 71)
8. The cells in the bark of woody plants which transport manufactured food downward. (page 46)

NAME ______________________

LETTER MAZE 4

The 27 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

G S N F R U K H V C X F X N Q M A C R O N U T R I E N T K S
I A P G O F M F S E B W R K Z R T X U L J G E M Q U Y P U O
B K S N P W J U I B G M M F V V D R X C Y U Y K O G K R G D
G X E M M J S I H U T B E F O E E A J S L X K Q U T O O P Y
C H L O R I N E L J H H T M C Z F U Y H R I C C N H B E I F
P A C S T H Y D R O G E N Z I G X R P I P U L A P F P P Q Z
A K T K G I G F U I N T H L W I H T A Q I M S S R S Y M P Q
P E R M E A B L E R U K I B S R W T U U O I O L D B U R C U
E Z I I A Y V M D U T T Q P V C T D F Q M H Z R G I O I K Q
M D Y I U S O Z T W R W S J Y Q Z H W R P M Q B S O Y N V B
C C Y T N K T I T E I E J T Y F V U E F Y Y C E Z D Z I H Y
M W U P F F S C F O E O J A K V A D R Q R P N O I E F N U S
Q B H E B V B F M G N B F J M X O V I M K G E X P U S Q J W
D O W E V M G P A O T A U U A D B X U Q A T G W C P A A G V
V W P G K X B K R M S D I D N F D I W M I D N V M R E G S Z
S B L J C J P O D D N S X E X V C X I M E J D D T W E R U L
M E D J X H B U T L S F O W M L O F O B F M V E K M K D L T
J B L C W C J I K A K I L S A E B L H W G W B P N X G K F U
E G I G N V F N T Z E W I C M K O B T X X C L R M D E H U U
N W N E F P X O R W M N L U W D G P M I W T W S A L G H R Z
R X Y X T R P J H G A I N Y K X E P O T R E M P H N J V M K
Q B T S U A Y B Y G P E C A Z S N W T C H O G D M E E N H J
W Z G Z O Q F T R I D A L R E F C V H N T C X I N B S H Z I
F Z C Y Y H L O O B V S R N O N I T R O G E N Y E O R T U F
B F L Q K D O F Y V I V A K A N J P O R Z B S A G A A A E B
B R G I Y R S L P S K G A H V S U T H O H I G M V E Z F H U
Z T P S C H O M O U N V B G S R A T R L S N A E F X N L I T
S L M I Z M X R S A K X T C G Q V A R S O I Y Y D Q S A N W
H A M U K K O M M G X Y S C O L L N M I Q E D Z N Z S C M P
M L V L X L D O L H S R Y I Z B Q A T R E Y M V M T R O A E
T Q L Y H S D B W T X W U G E I W M Q O L N B Z I N C J J Y
G F J C A V P B W U Z A S I A W E B U N N Y T M F V J S O N

- BORON
- CALCIUM
- CARBON
- CHLORINE
- CHLOROSIS
- COPPER
- DOLOMITE
- ENDODERMIS
- FERTILIZER
- HYDROGEN
- IRON
- MACRONUTRIENT
- MAGNESIUM
- MANGANESE
- MEMBRANE
- MICRONUTRIENT
- MICROORGANISM
- MOLYBDENUM
- NITROGEN
- NUTRIENT
- OXYGEN
- PERMEABLE
- PHLOEM
- PHOSPHORUS
- POTASSIUM
- SULFUR
- ZINC

NAME ____________________

STUDENT EXERCISE 4-A

PLANT NUTRIENT STUDIES BY POT CULTURE TECHNIQUE*

You could read all day about nutrient deficiencies, but until you have actually seen plants that are suffering from these deficiencies, you cannot appreciate what the lack of a nutrient can do to the plant's ability to grow. The purpose of this exercise is to familiarize you with a few typical nutrient deficiency symptoms.

MATERIALS:

- 10 to 14 6-inch flowerpots and saucers (2-quart milk cartons or tin cans can be substituted for flowerpots, and aluminum pie plates for saucers)
- polyethylene bags (8" x 4" x 18")
- chemicals as shown in Table 4-1
- balance, scale, or measuring spoon
- ruler
- waterproof felt tip pen
- graduated cylinder or measuring cup
- 50 to 70 pounds of soil. (Subsoils often are more deficient in nutrients than are topsoils. Check with your teacher for more details and possible sites of soils with deficiencies. If possible, collect soil when slightly moist. If soil contains large stones or clods, sieve through ½-inch screen. Avoid galvanized screen or buckets for handling zinc-deficient soils. Studies with zinc require use of pure chemicals, distilled water, and extreme precaution against contamination.)
- greenhouse or protected sunny place, such as south window sill, for growing plants
- water supply for watering plants. (Distilled or deionized water is essential for zinc and other micronutrient studies.)

PROCEDURE:

A. PREPARATION OF POTS AND MEDIA

1. Set out the flowerpots (or other containers). **Use at least two for each treatment.**
2. Cut off bottom of polyethylene bags and insert through hole in bottom of pots. Pull 3 inches of bag through hole and flare out at the bottom. Fold excess of bag over top edge of pot (Figure 4-1). (The bag is used to prevent possible contamination from the flowerpot.)
3. Mix soil on plastic sheet and weigh about 1600 grams (3.5 pounds) for each pot. If no balance or scales are available, simply fill pot to within 1 inch of the top.

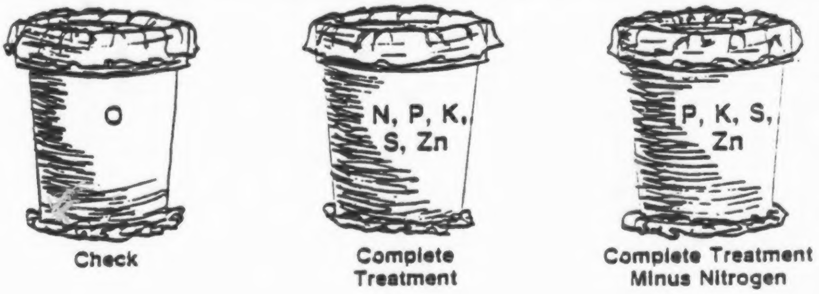


Figure 4-1. Flower pots with plastic liners for each treatment.

Plant Nutrient Studies by Pot Culture Technique, University of California, Agriculture Extension Service, Bulletin AXT-195.

(continued)

Student Exercise 4-A *(continued)*

SUGGESTED TREATMENTS

For soil with possible N, P, and/or K deficiencies

Symbols	**Treatment**
0	Check
N P K	Complete treatment
P K	Complete treatment minus nitrogen
N K	Complete treatment minus phosphorus
N P	Complete treatment minus potassium

For soils with possible N, P, K, S, and/or Zn deficiencies

Symbols	**Treatment**
0	Check
N P K S Zn	Complete treatment
P K S Zn	Complete treatment minus nitrogen
N K S Zn	Complete treatment minus phosphorus
N P S Zn	Complete treatment minus potassium
N P K Zn	Complete treatment minus sulfur
N P K S	Complete treatment minus zinc

4. Label all pots with felt tip pen, indicating chemicals or fertilizer to be applied.

5. Weigh or measure chemicals needed; (see Table 4-1 for exact amount needed of each chemical). Put chemicals on top of the soil in each pot according to the label.

6. Pour soil and fertilizer on the clean plastic sheet and thoroughly mix the chemical with the soil. Put the soil back in the same pot.

Table 4-1. AMOUNTS OF FERTILIZER CHEMICALS TO APPLY

Element	**Amounts in Solution (ppm*)**	**Chemical Name**	**Formula**	AMOUNTS TO APPLY **Grams per Pot**	**Tsp** per 10 Pots**
N	100	Ammonium nitrate	NH_4NO_3	0.46	1½
P	100	Mono calcium phosphate	$Ca(H_2PO_4)_2 \cdot H_2$	0.65	1½
K	100	Potassium chloride	KCl	0.30	1
S	25	Calcium sulfate	$CaSO_4 \cdot 2H_2$	0.22	1
Zn	5	Zinc sulfate or	$ZnSO_4 \cdot 7H_2O$	0.036	¼
		Zinc chloride or	$ZnCl_2$	0.017	⅓
		Zinc nitrate	$Zn(NO_3)_2 \cdot 6H_2O$	0.036	¼

*"ppm" means *parts per million*.

**Dissolve this amount in 100 milliliters of water and put 10 milliliters of this solution in each pot. If a graduated cylinder is not available, use a measuring cup. "Tsp" means *teaspoon*.

(continued)

Student Exercise 4-A *(continued)*

B. PLANTING AND GROWING THE CROP

1. In a nutrient study a well-selected plant is one that is (a) capable of rapid growth; (b) resistant to diseases and insects; (c) sensitive to nutrient deficiencies; and (d) showing deficiency symptoms slowly. Sweet corn (Golden Cross Bantam) and tomatoes (Pearson or related varieties) both meet these requirements.
2. If corn is used, plant six seeds per pot about 1 inch deep. When the plants reach 1 to 2 inches in height, thin to three per pot. If tomatoes are used, plant about ten seeds about ½ inch deep and thin to three plants per pot. Corn normally emerges in 5 to 7 days, and tomatoes in 7 to 10 days.
3. After planting the seeds, carefully moisten with 1 cup of water and cover the pots with a paper towel or newspaper for several days to reduce evaporation.
4. Remove paper as plants start to emerge. If surface dries out, add ½ cup of water.
5. After plants emerge, water as needed. (Avoid overwatering as it may encourage seedling diseases.) After thinning, the plants probably will require daily watering. On sunny days (after the plants reach 6 to 12 inches in height) water twice a day. It is important to add enough to wet the whole soil mass.
6. Observe the growing plants and record your observations here:

Treatment	**Symptoms Observed**

EVALUATION:

1. Fertilizer was incorporated as directed. ______________
2. Seeds were planted and grown as directed. ______________
3. The chart was completed accurately and neatly. ______________
4. All materials and equipment used were cleaned and stored properly. ______________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 4-B

DETERMINING AMOUNTS OF FERTILIZER TO APPLY

The fertilizer recommendation sheets that nursery operators receive are varied in design. The recommendations for a lawn would be quite different from those for row crops, so the forms are also different. The following exercise is designed to familiarize you with a typical recommendation sheet.

MATERIALS:

- Agronomic recommendation sheet "Lime and Fertilizer Recommendations" (page 4-15)
- Supplemental chart for nitrogen materials, Table 4-2 (page 4-16)

PROCEDURE:

1. On the "Lime and Fertilizer Recommendations" sheet, consider sample 2A.

   What is the present pH of the soil? ______________

2. If you decide to correct the present deficiency and follow Plan A:

   a. How many pounds of N should be applied per acre? ______________

   b. How many pounds of P_2O_5 should be applied per acre? ______________

   c. How many pounds of K_2O should be applied per acre? ______________

3. If you decide to apply 25-25-25 at planting time, you now need to be concerned with only:

   a. ______________ lb./A of N

   b. ______________ lb./A of P_2O_5

   c. ______________ lb./A of K_2O

4. Since ammonium sulfate is easy to obtain from a fertilizer dealer, you decide to use it to meet the N requirement.

   a. What is the grade of ammonium sulfate? (See Table 4-2, "Various Nitrogen Materials.")

   ____

   b. Since you need __________ lb./A of N, divide this figure by __________ lb./100 lb. of ammonium sulfate.

   c. The result is a total of ______________ lb. of ammonium sulfate to apply per acre.

   d. Since there are __________ acres in this field, you would order a total of __________ lb. of ammonium sulfate from the dealer.

5. If you decide to use 0-0-60 to meet the K_2O requirement, you can determine the need for total pounds of 0-0-60 by the following computations:

   a. Since you need ______________ lb./A of K_2O, divide this figure by ______________ lb./100 lb. of 0-0-60.

   b. Since there are ______________ acres in this field, you would order a total of ______________ lb. of 0-0-60 from the dealer.

(continued)

(continued)

FARMER JOHN DOE
R. R. 3
ANYTOWN, U.S.A. 00011
COUNTY WOOD

SOIL TESTING LABORATORY — COOPERATIVE EXTENSION SERVICE

INDUSTRY LIME FERTILIZER CO.
22 GREEN THUMB ST.
ANYTOWN, U.S.A. 00011

RECEIVED SAMPLE 6-05 DATE PRINTED 6-09 REPORT NO. 46524 PLAN NO. 3

LIME AND FERTILIZER RECOMMENDATIONS

PLAN A – IMMEDIATE BUILD-UP OF SOIL FERTILITY AND MAINTENANCE

PLAN B – GRADUAL BUILD-UP OF SOIL FERTILITY AND/OR MAINTENANCE

FOLLOW PLAN A when corrective fertilizer is used.

FOLLOW PLAN B when corrective fertilizer is not used.

YOUR SAMPLE NUMBER	CORRECTIVE LIME Ag Ground in T/A to raise soil to pH indicated: pH	T/A	CORRECTIVE FERTILIZER PHOSPHATE P_2O_5 lb/A	POTASH K_2O lb/A	YEAR	CROPS	YIELD GOALS	PLAN A ANNUAL CROP FERTILIZER NITROGEN N lb/A	PHOSPHATE P_2O_5 lb/A	POTASH K_2O lb/A	PLAN B ANNUAL CROP FERTILIZER NITROGEN N lb/A	PHOSPHATE P_2O_5 lb/A	POTASH K_2O lb/A	COMMENTS SEE BELOW
					LAST	CONTINUOUS CORN								
1A	6.5	2.5	200	0	1970	CONTINUOUS CORN	120 BU/A	140	40	20	140	60	20	
1					1971	CONTINUOUS CORN	145 BU/A	180	50	30	180	70	30	
					1972	CONTINUOUS CORN	150 BU/A	220	60	40	220	80	40	
	pH	T/A			LAST	CORN								
2A	6.5	0.0	0	200	1970	CORN	150 BU/A	220	25	70	220	25	120	
2	7.0	0.0			1971	WHEAT (SEEDED)	50 BU/A	20	20	35	20	20	55	
					1972	ALFALFA	5 T/A	***	10	140	***	10	195	
	pH	T/A			LAST	CORN								
3A	6.5	4.5	0	0	1970	MEADOW SEEDING		***	***	***	20	40	40	
3	7.0	5.5			1971	MEADOW	5 T/A	***	***	***	125	10	110	1
					1972	MEADOW	5 T/A	***	***	***	125	10	110	2

COMMENTS:

1, 2 IF 50 PERCENT OR MORE LEGUME OMIT N, IF 20 PERCENT OR LESS APPLY 50 LBS MORE N.

1, 2 SPLIT NITROGEN INTO SPRING AND FALL APPLICATIONS.

SAMPLE IDENTIFICATION				SAMPLE INFORMATION					RESULTS OF LABORATORY ANALYSIS FOR EACH SAMPLE													
									← Standard Test →				← Standard Test Plus Calcium and Magnesium →							← Minor Elements →		
												EXCHANGEABLE				PERCENT BASE SATURATION (Computed)				AVAILABLE		
	YOUR SAMPLE NUMBER	CODE NUMBER	LAB NUMBER	SOIL NUMBER	SIZE OF AREA ACRES	DEPTH PLOWED	LAST LIMED YEAR	T/A	SOIL pH	LIME TEST INDEX	AVAILABLE PHOSPHORUS P lb/A	POTASSIUM K lb/A	CALCIUM Ca lb/A	MAGNESIUM Mg lb/A	CATION EXCHANGE CAPACITY meq/100g	% Ca	% Mg	% K	CALCIUM MAGNESIUM Ca/Mg RATIO	MANGANESE Mn lb/A	BORON B lb/A	ZINC Zn lb/A
1	1A	00010	0110	608	20	9	1966	2	6.3	6.6	17	390	3780	317	17.0	55.5	7.8	2.9	7.2	50	0.5	5.0
2	2A	00011	0111	602	12	8	1969	5	6.4	6.7	132	145	2875	428	13.5	53.3	13.2	1.4	4.0	32	1.5	16
3	3A	00012	0112	608	5	8			5.5	6.4	200	298	2575	142	16.1	40.1	3.7	2.4	10.9		0.5	

Lime Test Index Use when adjusting lime recommendation (See Agronomy Guide)

Student Exercise 4-B *(continued)*

Table 4-2. VARIOUS NITROGEN MATERIALS

Ammonium sulfate (20.6-0-0)
Ammonium nitrate (33.5-0-0)
Urea (45-0-0)
Anhydrous ammonia (82.25-0-0)
Nitrogen solution - Low pressure (41-0-0)
Nitrogen solution - No pressure (28-0-0)
Aqueous ammonia solution (24-0-0)

EVALUATION:

Questions were answered neatly and accurately. ______________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 4-C

TURFGRASS MAINTENANCE INFORMATION

An interesting part of the "Turfgrass Report" is the back page (page 4-19) which gives instructions on how to use the report. Once corrective measures have been taken, a maintenance program should be initiated and carried out each year to insure a continuous supply of nutrients for the grass. In the middle of the back of the report are five columns of fertilizer grades. These are the most popular grades usually available at garden centers. Beneath these columns are the recommendations for an annual maintenance program for particular types of turf.

MATERIALS:

- A copy of "Turfgrass Report" (see pages 4-18 — 4-19)

QUESTIONS:

1. If you have Windsor turf, how many pounds of 16-8-4 would you apply per 1000 square feet June 1-15? __________
2. If the above lawn were 4,000 square feet, how many **total** pounds of 16-8-4 would you apply June 1-15? __________
3. If your lawn of common Kentucky Bluegrass covered an area of 3,000 square feet, how many pounds of 20-10-10 would you buy to meet the yearly recommendation? __________

EVALUATION:

Questions were answered accurately and neatly. __________

FINAL GRADE __________

(continued)

TURFGRASS REPORT **SOIL TESTING LABORATORY**

NAME John Doe Nurseryman

ADDRESS 1234 Avenue A

CITY,STATE,ZIP Anywhere, USA 00011

INDUSTRY ____________

ADDRESS ____________

CITY,STATE,ZIP ____________

COUNTY Yours

CODE NO. BU268

____

DATE ____________

SOIL IDENTIFICATION			SOIL TEST RESULTS (See enclosed sheet for interpretation)					RECOMMENDATIONS			
								CORRECTIVE LIMESTONE	CORRECTIVE FERTILIZER		
LAB.NO.	COUNTY CODE NUMBER	YOUR SOIL SAMPLE NUMBER	pH	LIME DEFICIT TONS/ACRE	AVAILABLE PHOSPHORUS lb/ACRE	EXCHANGEABLE POTASSIUM lb/ACRE	* SOLUBLE SALTS	lb/1000 sq.ft.	lb/1000 sq.ft.	GRADE OR EQUIVALENT	MAINTENANCE PROGRAM ESTABLISHMENT (SEEDING PROGRAM)
4051	BU268	1	5.8	3.5	8	117	30	80	12 8	0-46-0 0-0-60	See
4052	BU268	2	6.5	0	55	235	35	None	None	None	Recommendations
											on the
											back
											of this
											sheet

HOW TO USE THIS REPORT:

1. Correct soil fertility status as shown in columns "CORRECTIVE FERTILIZER AND CORRECTIVE LIMESTONE".
2. For ESTABLISHMENT AND MAINTENANCE apply fertilizer as indicated in the appropriate table on reverse side.

AT ESTABLISHMENT: Fertilizer and limestone to correct soil fertility status should be worked into upper 6 inches of soil.

AT MAINTENANCE: Fertilizer and limestone to correct soil fertility status should be applied in September and/or March.

ADDITIONAL REMARKS:

Sample No. 1. - 0-0-60 should be split into at least two applications Spring and Fall

(continued)

*Injury to turfgrasses may result when the soluble salts reading is 250 or above.

Student Exercise 4-C *(continued)*

HOW TO USE THE TURFGRASS REPORT

I. When needed the amount of limestone to apply to correct soil acidity is shown on front of report.

II. When soil test values are low (phosphorus below 32 lb/Acre, potassium below 141 lb/Acre)
  A. Apply Corrective fertilizer as recommended on front of report.
  B. Apply Maintenance fertilizer as recommended in table below.

III. When soil test values are high (phosphorus above 32 lb/Acre, potassium above 141 lb/Acre)
  A. Corrective fertilizer is not needed and is not recommended on front of report.
  B. Apply Maintenance fertilizer as recommended below.

An example of how to choose the right Maintenance program:

Step 1: Choose a fertilizer grade that is available in your locality from the table below.
Step 2: Choose the portion of the table that lists the type of turf in your lawn.
Step 3: Go across the table from the type of turf to the column below the fertilizer grade you are using.

For example:

1. If you buy 12-4-8 and
2. You have Common Kentucky Bluegrass
3. You would apply: (a) 18#/1000 sq.ft. of 12-4-8 fertilizer Sept. 1-15.
   (b) 9#/1000 sq.ft. of 12-4-8 fertilizer May 15-June 15.
   (c) 9#/1000 sq.ft. of 12-4-8 fertilizer July 1-15.

MAINTENANCE (ANNUAL) FERTILIZATION PROGRAM FOR TURF

		Examples of typical lawn fertilizer grades. Similar grades may be substituted.				
		10-6-4 10-3-7 10-5-5	12-6-6 12-5-7 12-4-8 13-3-9 12-3-3 12-7-5 12-6-3	16-8-8 15-10-5 16-8-4 15-5-5 16-4-8	20-10-10 20-10-5 20-8-8 20-5-5	23-12-6 25-5-10 24-6-6 23-7-7
Type of Turf	Date to Apply	Pounds of the above fertilizer grade per 1000 sq.ft.				
Merion, Pennstar, Windsor, A-20 Ky. Bluegrasses and Bentgrass	Sept. 1-15	20	18	13	10	8
	Mar. 15-Apr. 15	20	18	13	10	8
	June 1-15	10	9	7 1/2	5	4
	July 15-Aug. 10	10	9	7 1/2	5	4
Common Kentucky Bluegrass	Sept. 1-15	20	18	13	10	8
	May 15-June 15	10	9	7 1/2	5	4
	July 1-15	10	9	7 1/2	5	4
Creeping Red Fescue	Sept. 1-15	10	9	7 1/2	5	4
	June 15-July 15	10	9	7 1/2	5	4
Tall Fescue	Sept. 1-15	10	9	7 1/2	5	4
	Apr. 1-30	10	9	7 1/2	5	4
	June 15-July 15	10	9	7 1/2	5	4

ESTABLISHMENT FERTILIZATION PROGRAM

(Apply in addition to Corrective Fertilizer recommended on front of report when seeding a new lawn).

Type of Turf	Recommendations
Merion, Pennstar, Windsor, A-20 Ky. Bluegrasses and Bentgrass	23 lb/1000 sq.ft. of 15-20-10 or equivalent in upper 2 inches of seedbed.
Common Kentucky Bluegrass and Fescue	23 lb/1000 sq.ft. of 10-20-10 or equivalent in upper 2 inches of seedbed.

To convert lb/1000 sq.ft. to lb/Acre multiply by 43.5.

NAME ____________________

QUIZ - CHAPTER 4

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. Micronutrients are needed by plants in large quantities.

T F 2. Much of the phosphorus in soils is tied up in forms that are not available to plants.

T F 3. In alkaline soils iron becomes insoluble and unavailable to plants.

T F 4. Plants suffering from lack of copper usually have wilted upper leaves.

T F 5. Chlorine deficiency is a frequent problem.

T F 6. "pH" refers to nitrogen concentration in the soil.

T F 7. The pH of soil does not have an effect on availability of nutrients.

T F 8. Nutrients are absorbed into plants through root hairs.

T F 9. All soil samples sent to a laboratory for analysis should be dry.

T F 10. Plant analysis generally serves as a supplement to soil test information.

MULTIPLE CHOICE

Read each item and decide which choice correctly completes the statement or answers the question. Circle the letter of your choice.

11. Which of the following is a macronutrient?

    A. magnesium
    B. manganese
    C. iron
    D. copper

12. Which of the following elements is called the "building block of cells"?

    A. nitrogen
    B. potassium
    C. calcium
    D. molybdenum

13. Which of the following is a complete fertilizer?

    A. 0-10-30
    B. 15-30-15
    C. 28-0-0
    D. nitrogen

14. Yellowing of plant leaves can be caused by a lack of:

    A. manganese
    B. iron
    C. nitrogen
    D. all of the above

15. Which of the following elements is **not** found in a complete fertilizer?

    A. manganese
    B. magnesium
    C. phosphorus
    D. nitrogen

16. The most accurate way to determine the amount of fertilizer needed to grow nursery stock is to . . .

    A. Make an educated guess based on how much fertilizer you normally use.

    B. Take a soil sample and analyze it yourself.

    C. Have the soil tested by a state or commercial soil testing laboratory and follow their recommendations.

    D. Follow the recommendations from a good book on nursery production.

(continued)

QUIZ - page 2

17. Plant analysis gives you information . . .

    A. about nutrients which are actually in the plant
    B. about the identification of plants
    C. about lime recommendations
    D. about micronutrients only

18. A complete fertilizer is . . .

    A. a fertilizer which contains no filler

    B. a fertilizer which contains all 13 elements necessary for plant growth

    C. a fertilizer which contains N, P, and K

    D. a fertilizer which dissolves readily (completely) in water

19. The reason for making a composite soil sample is . . .

    A. to get enough soil to be properly tested.

    B. so that every part of the field or area has an equal chance of being tested.

    C. so that the sample accurately represents the entire area to be tested.

    D. all of the above.

20. The contents of a bag of 15-10-30 fertilizer are . . .

    A. 15 lb. phosphoric acid, 10 lb. nitrogen, 30 lb. potash

    B. 15 lb. nitrogen, 10 lb. phosphoric acid, 30 lb. potash

    C. 15 lb. nitrogen, 10 lb. potash, 30 lb. phosphoric acid

    D. 15 lb. potash, 10 lb. nitrogen, 30 lb. phosphoric acid

21. Nitrogen is important in ________ development.

    A. leaf
    B. stem
    C. fruit or seed
    D. leaf, stem, and fruit or seed

22. Which of the following is a micronutrient?

    A. potassium
    B. calcium
    C. sulfur
    D. boron

23. The procedure by which plant tissue is checked to determine the presence and amount of nutrients in the plant is called . . .

    A. random sampling
    B. soil testing
    C. plant analysis
    D. sample processing

24. When processing a soil sample the soil clods should be . . .

    A. dried and sent to the laboratory
    B. crushed to a powder (pulverized thoroughly) and air dried
    C. broken up and dried in a hot oven
    D. broken up and spread out to dry at room temperature

25. Which of the following is a differentially permeable membrane?

    A. bark
    B. endodermis
    C. dolomite
    D. meristem

ANSWER KEY - CHAPTER 4

Key Questions, Part 1 - page 4-4

MACRONUTRIENTS/MICRONUTRIENTS

1. Macronutrients are used by plants in large quantities. Micronutrients are needed only in very small quantities.
2. Nine elements are considered macronutrients for plants.
3. Nitrogen is a building block of protein. It is also a component of chlorophyll; i.e., it is partially responsible for the green color in leaves. Nitrogen is also important in leaf, stem, and fruit or seed development.
4. Microorganisms in soil use nitrogen for food. They may tie up available nitrogen so it cannot be used by plants.
5. Phosphorus causes fruit to ripen faster. Overall it contributes to a quality crop.
6. Most of the phosphorus in soil is tied up in forms not available to plants.
7. The exact function of potassium is unknown. However, it is believed that potassium makes plants more resistant to diseases and cold weather. It also helps in the production of sugar.
8. Sulfur is a major ingredient of some amino acids used to build proteins in plants.
9. Calcium is called the building block of cells. It is needed to form cell walls.
10. Magnesium is the key element in chlorophyll. It enables phosphorus to get where it belongs in plants.
11. The seven micronutrients needed by plants are iron, copper, manganese, zinc, molybdenum, boron, and chlorine.
12. In alkaline soil iron becomes insoluble and unavailable to plants.

Key Questions, Part 2 - page 4-6

NUTRIENT ENTRY INTO PLANTS

1. Plants take up nutrients from the soil in ionic form.
2. A differentially permeable membrane "allows" the passing of solution through the membrane to different degrees. Some solutions are not "allowed" through at all.
3. *Ion Exchange Theory* - Cations and anions are exchanged on a one-for-one basis, so concentrations inside the cell and in the soil solution remain the same.

   Carrier Theory - This theory is that a substance found in the plant cell passes through the differentially permeable membrane. This substance then passes to the outside of the cell and into the soil solution. Here it picks up a nutrient and "carries" it back into the cell through the membrane. Once inside, this carrier releases the nutrient.

   Mass Flow Theory - Soil nutrients are dissolved in water. As water moves into the cell through the cell wall, it just happens to carry some dissolved nutrients with it.

FERTILIZERS

4. A complete fertilizer contains nitrogen, phosphorus and potassium.
5. An incomplete fertilizer contains only one or two of the three elements- nitrogen, phosphorus and potassium.
6. A fertilizer grade is a set of numbers which represents the proportion of nitrogen, phosphorus and potassium in a fertilizer.

Key Questions, Part 3 - page 4-7

SOIL TESTING AND PLANT ANALYSIS

1. Soil tests are made to try to determine the present condition of the soil and what can be done to improve the soil.

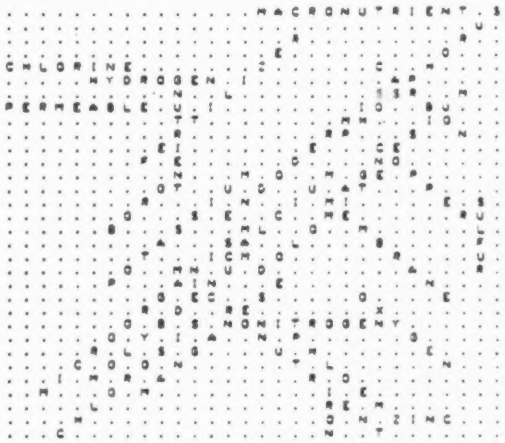
Answers *(continued)*

2. A composite soil sample provides a representative picture of the field as a whole.
3. 1) Break up clods and spread soil to dry at room temperature.
   2) When dry, thoroughly mix the soil sample.
   3) Place a pint of this sample in a clean paper bag or other suitable container.
   4) Label the sample.
   5) Fill out the soil test form.
   6) Take the dry soil sample and test form to your county agricultural extension agent or mail it to the state testing lab.
4. Plant analysis is a procedure for determining plant nutrient needs. It is used as a supplement to soil testing.
5. Plant analysis results tell you the amount of 13 nutrient elements in the plant.

Terms to Remember - page 4-8

1. phloem
2. endodermis
3. complete fertilizer
4. dolomite
5. differentially permeable membrane
6. incomplete fertilizer
7. plant analysis
8. iron chlorosis
9. nutrient
10. micronutrients
11. macronutrients
12. microorganism

Letter Maze - page 4-10



Crossword Puzzle - page 4-9

ACROSS	DOWN
1. micronutrient	1. macronutrient
4. complete	2. incomplete
7. plant	3. nutrient
9. iron	5. permeable
10. micro	6. endodermis
	8. phloem

QUIZ

True or False - page 4-20

1. false
2. true
3. true
4. true
5. false
6. false
7. true
8. true
9. true
10. true

Multiple Choice - page 4-20

11. A
12. C
13. B
14. D
15. A
16. C
17. A
18. C
19. C
20. B
21. D
22. D
23. C
24. D
25. B

GLOSSARY - Chapter 4

complete fertilizer - a fertilizer containing nitrogen, phosphorus and potassium.

differentially permeable membranes - membranes which allow, to different degrees, the passing of solution through them.

dolomite - a mineral (calcium magnesium carbonate) used to raise the pH of soil.

endodermis - a specialized tissue in the roots and stems of certain plants.

incomplete fertilizer - a fertilizer that contains only one or two of the three major plant nutrients, e.g., 28-0-0 or 0-10-30.

iron chlorosis - yellowing symptoms which result from a plant's reaction to an alkaline soil in which iron has become insoluble and unavailable to the plant.

macronutrient - chemical element which is required in considerable abundance for the growth and survival of plants.

micronutrient - element essential to the growth of plants, but required only in very small amounts.

microorganism - a microscopic plant or animal.

nutrient - a substance which a plant synthesizes into food.

phloem - meristem cells which conduct food downward. Located in the bark of woody plants next to the cambium.

plant - a tree, shrub, or herb - what the nursery industry deals with.

plant analysis - analysis of plant tissue to determine what nutrients are present in a plant and in what amounts.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 4

T4-1 *(Student Manual*, pages 67-68)

Nine elements are considered macronutrients for plants. Each nutrient plays a specific role in plant growth. Some are involved in more than one role.

Questions: What is the role of nitrogen in plants? Phosphorus? Potassium? Sulfur? Calcium? Magnesium?

……

T4-2 *(Student Manual*, pages 68-69)

Micronutrients are needed in small amounts by plants. But "small amount" does not mean insignificant or worthless. These nutrients must be present if plants are to grow well.

Questions: What is the role of iron in plants? Copper? Manganese? Zinc? Molybdenum? Boron? Chlorine?

……

T4-3 *(Student Manual*, pages 70-72)

This figure shows how a negatively charged clay particle is attracting some nutrients that are in the soil. Notice that for each negative charge (—) on the soil particle, there is one positive (+) attraction. Other ions present in the solution are just "floating around" waiting to be attracted to the particle.

……

T4-4 *(Student Manual*, pages 70-72)

A soil that contains a large number of H^+, in proportion to other positively charged ions, is an acidic soil. By adding lime to this soil, you could raise the pH and make it less acid.

……

T4-5 *(Student Manual*, pages 70-72)

An alkaline soil contains very few H^+ in proportion to other positively charged ions. This figure shows how this would appear in the soil solution.

……

T4-6 *(Student Manual*, pages 70-72)

This figure represents a cross-section of a plant root. The xylem carries nutrients up into plants and the phloem carries food downward. Root hairs absorb water and therefore take up nutrients found in the soil solution.

The endodermis contains **differentially permeable membranes** which allow the passing of solutions to different degrees. Some solutions are not "allowed" through at all.

……

T4-7 *(Student Manual*, pages 70-73)

One of the theories as to how nutrient solutions pass into plants is the **carrier theory**. A substance found in the plant cells passes through the differentially permeable membrane. This substance then passes to the outside of the cell and into the soil solution. Here it picks up a nutrient and "carries" it back into the cell through the membrane. Once inside, this carrier releases the nutrients. The nutrient is now available for use by the plant.

……

(continued)

Narratives for Transparency Masters *(continued)*

T4-8 *(Student Manual*, pages 70-73)

This figure illustrates the **ion exchange theory** in which there is a concentration of negatively charged ions (anions) inside the cell. Outside the cell, in the soil solution, there is a concentration of positively charged ions (cations).

According to this theory, a cation is allowed to pass through the membrane into the cell. In exchange, an anion within the cell passes out of the cell through the membrane into the soil solution. Both concentrations remain the same, since only a simple exchange takes place.

T4-9 *(Student Manual*, pages 73-75)

A fertilizer containing N, P, and K is called a **complete fertilizer**. The amounts of each element are in a certain specified ratio to each other. This ratio or grade is listed on the fertilizer bag.

Question: In this bag, how much P is there in relation to N and K?

T4-10 *(Student Manual*, pages 75-77)

To obtain a representative soil sample, you should gather at least 15 cores. A total of 20 or 30 cores is preferred if the soil has been recently limed and/or fertilized. Take the same amount of soil at each site, and take the cores at random in a zigzag pattern over the area involved.

Question: Why is it important to take more than one core for sampling?

T4-11 *(Student Manual*, pages 75-77)

Before taking your soil sample, divide the field into uniform areas according to different situations. Some examples of field situations are shown in this figure.

T4-12 *(Student Manual*, pages 75-80)

This is a sample of the type of form you might need to fill out before sending a soil sample to a laboratory for analysis.

Question: What kind of information will you receive from the soil testing laboratory after they have analyzed your soil?

T4-13 *(Student Manual*, pages 80-85)

This is a sample of the type of form you might need to fill out before sending plant tissue (leaves) to a laboratory for analysis?

Question: What kind of information will you receive from a plant analysis laboratory?

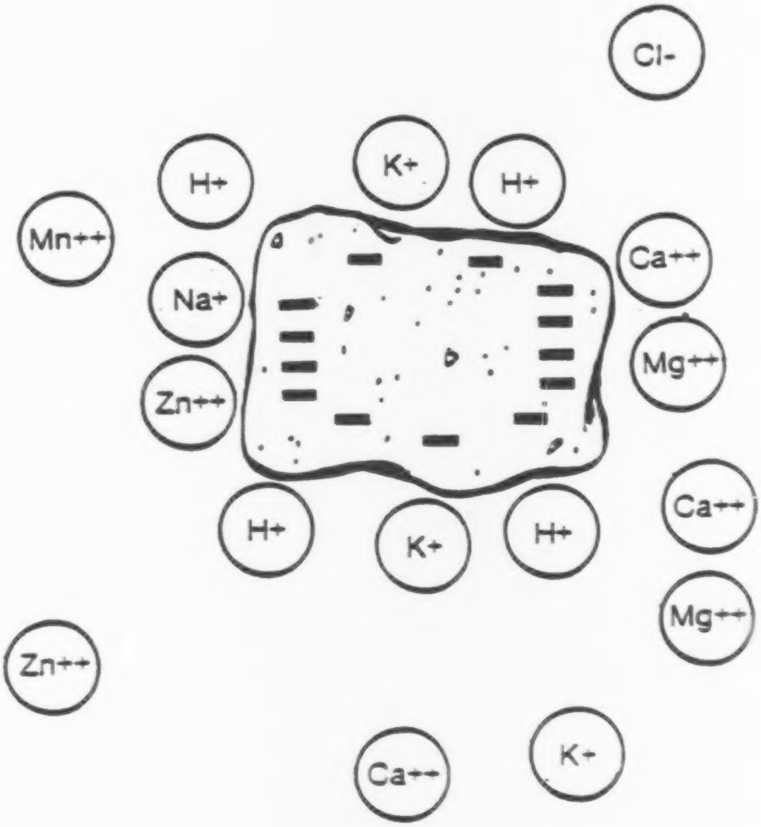
MACRONUTRIENTS

1.	C	Carbon
2.	H	Hydrogen
3.	O	Oxygen
4.	N	Nitrogen
5.	P	Phosphorus
6.	K	Potassium
7.	S	Sulfur
8.	Ca	Calcium
9.	Mg	Magnesium

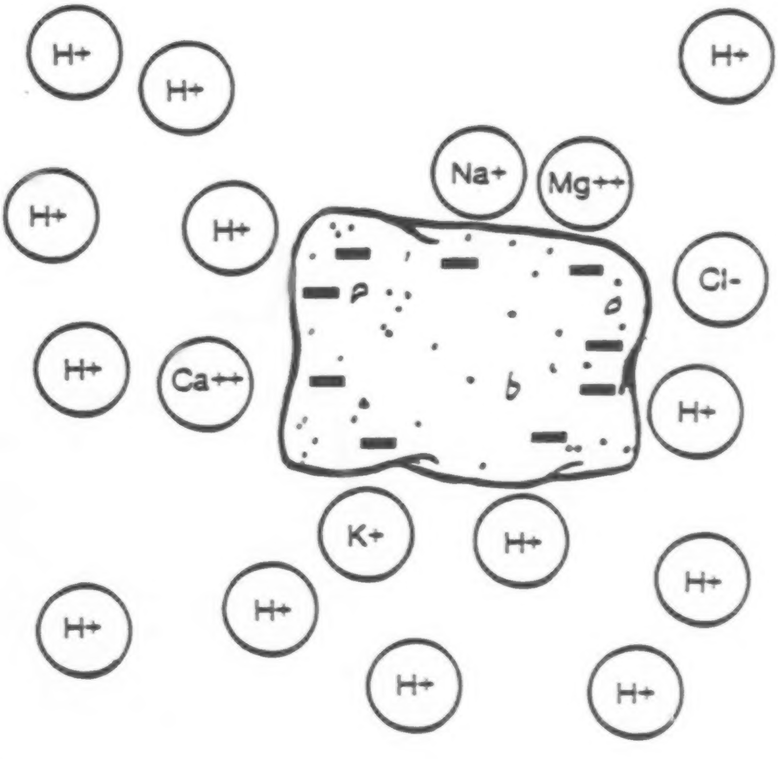
MICRONUTRIENTS

1.	Fe	Iron
2.	Cu	Copper
3.	Mn	Manganese
4.	Zn	Zinc
5.	Mo	Molybdenum
6.	B	Boron
7.	Cl	Chlorine

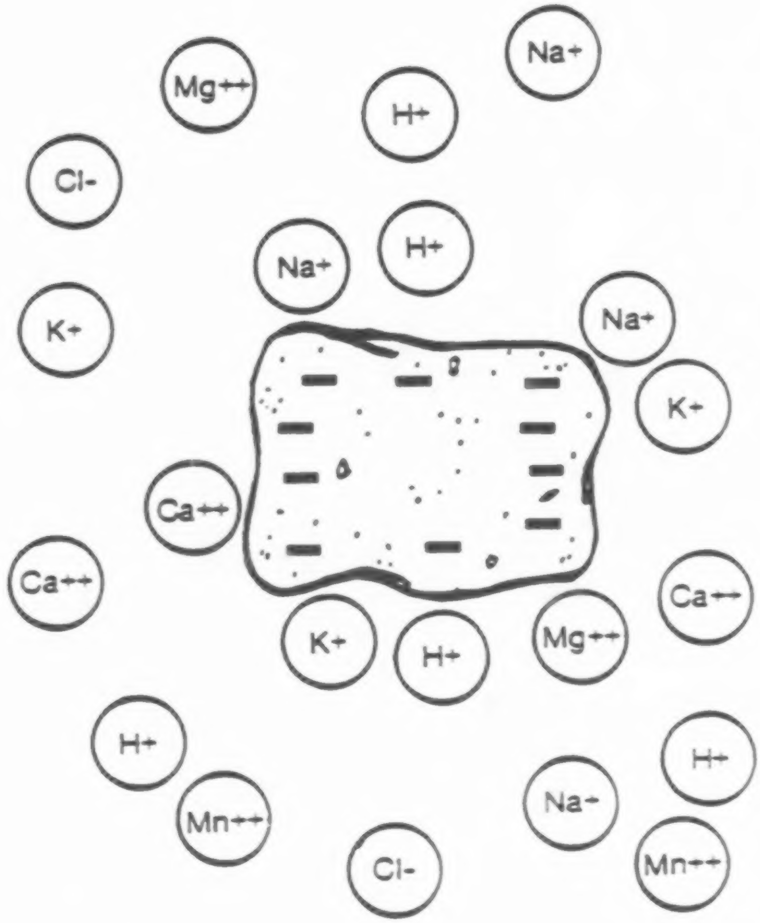
Negatively Charged Clay Particle


Cl-
K+
H+
H+
Mn++
Ca++
Na+
Mg++
Zn++
H+
K+
H+
Ca++
Mg++
Zn++
Ca++
K+

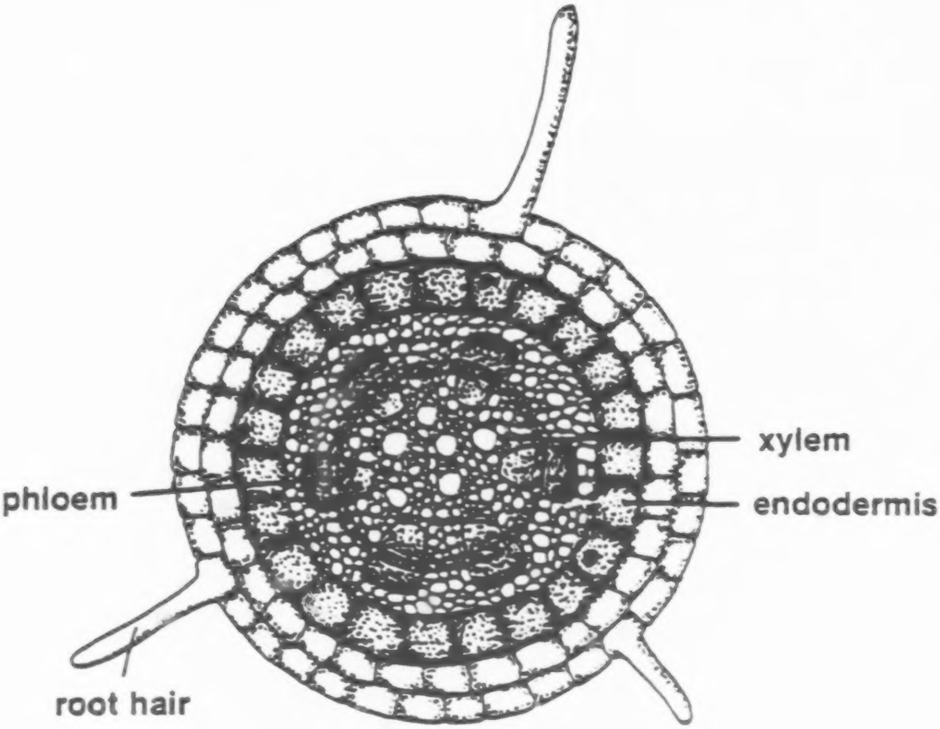
Soil Particles Surrounded by a Large Number of Hydrogen Ions


H+
H+
H+
Na+
Mg++
H+
H+
Cl-
H+
Ca++
H+
K+
H+
H+
H+
H+
H+
H+

Soil Particle Surrounded by Relatively Few Hydrogen Ions

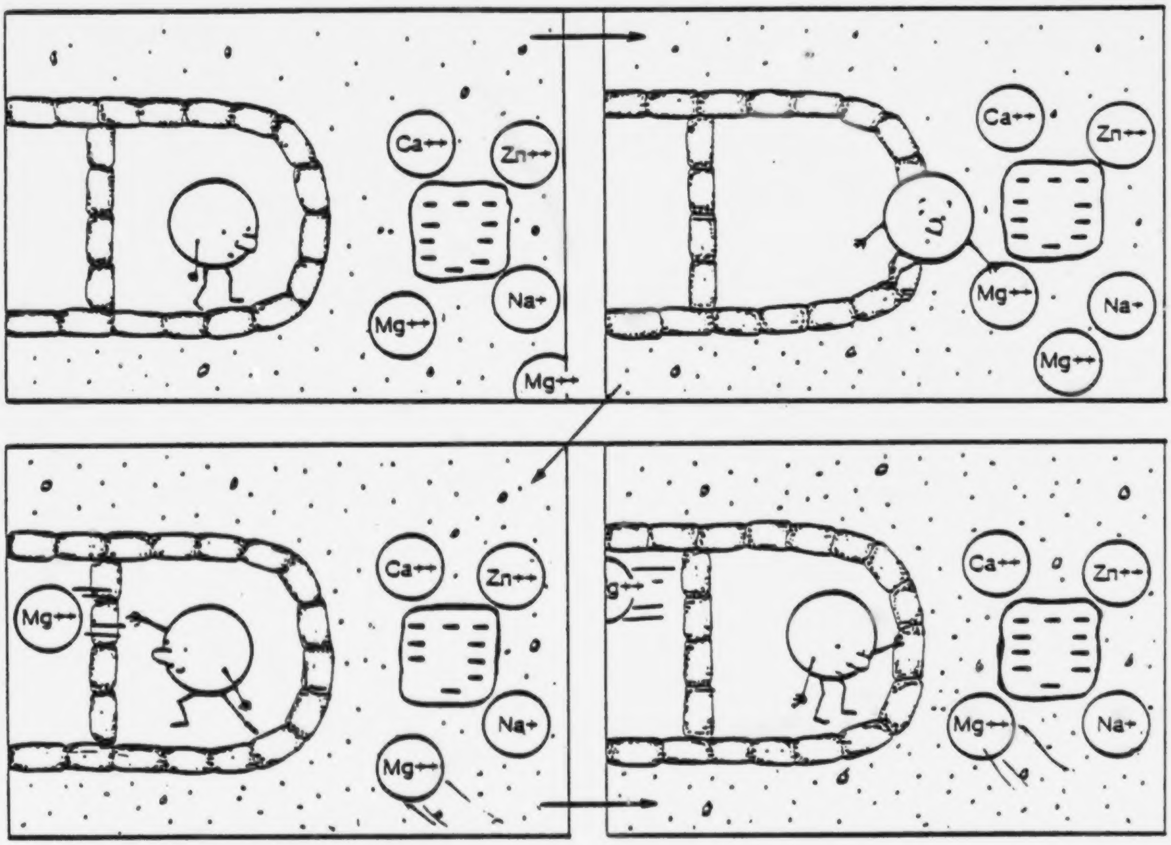

Na+
Mg++
H+
Cl-
H+
Na+
Na+
K+
K+
Ca++
Ca++
Ca++
K+
H+
Mg++
H+
H+
Na+
Mn++
Cl-
Mn++

Cross-section of a Plant Root

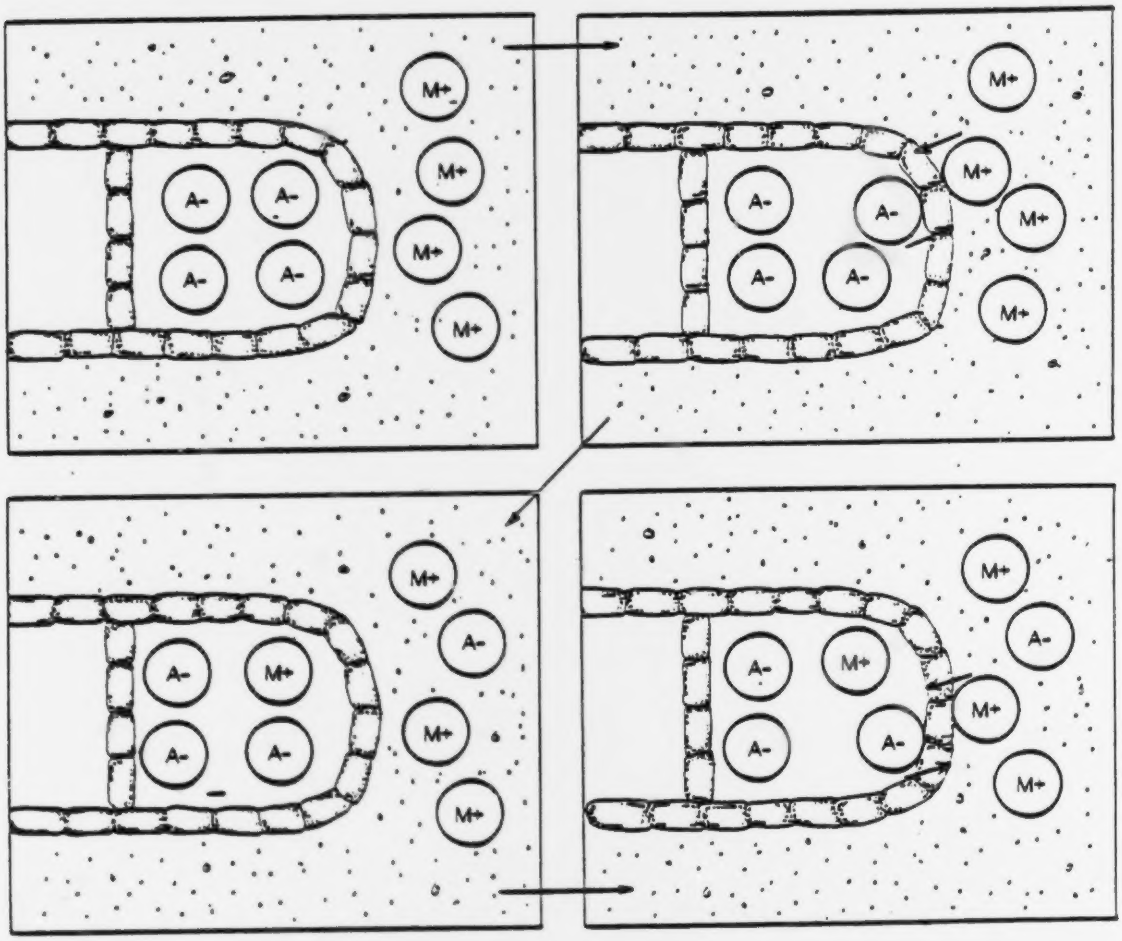

xylem
phloem
endodermis
root hair

192

Carrier Theory for Nutrient Entry into Plants

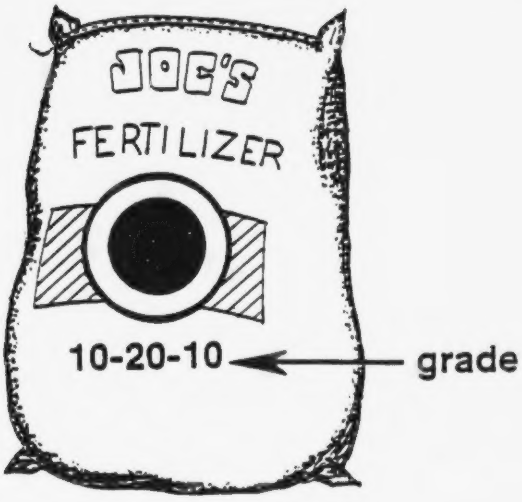

Ca++
Zn++
Mg++
Na+
Mg++
Ca++
Zn++
Mg++
Na+
Mg++
Mg++
Ca++
Zn++
Na+
Mg++
g++
Ca++
Zn++
Mg++
Na+

Simple Exchange Theory for Nutrient Entry into Plants

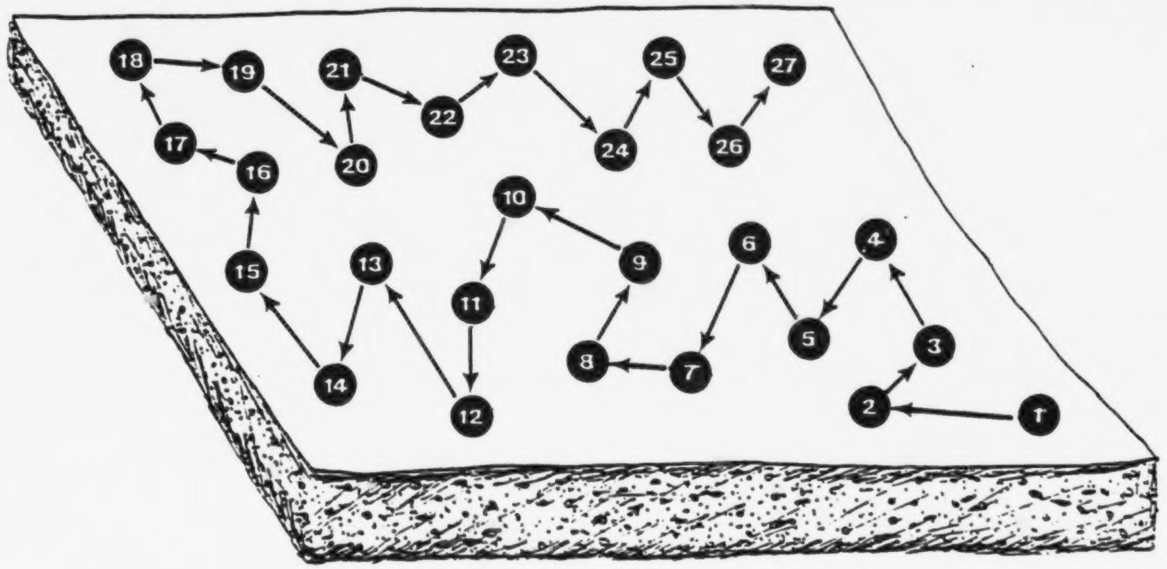

M+
M+
M+
M+
A-
A-
A-
A-
M+
M+
M+
M+
A-
A-
A-
A-
M+
A-
M+
M+
A-
M+
A-
A-
M+
A-
M+
M+
A-
M+
A-
A-

194

Sack of Commercial Fertilizer

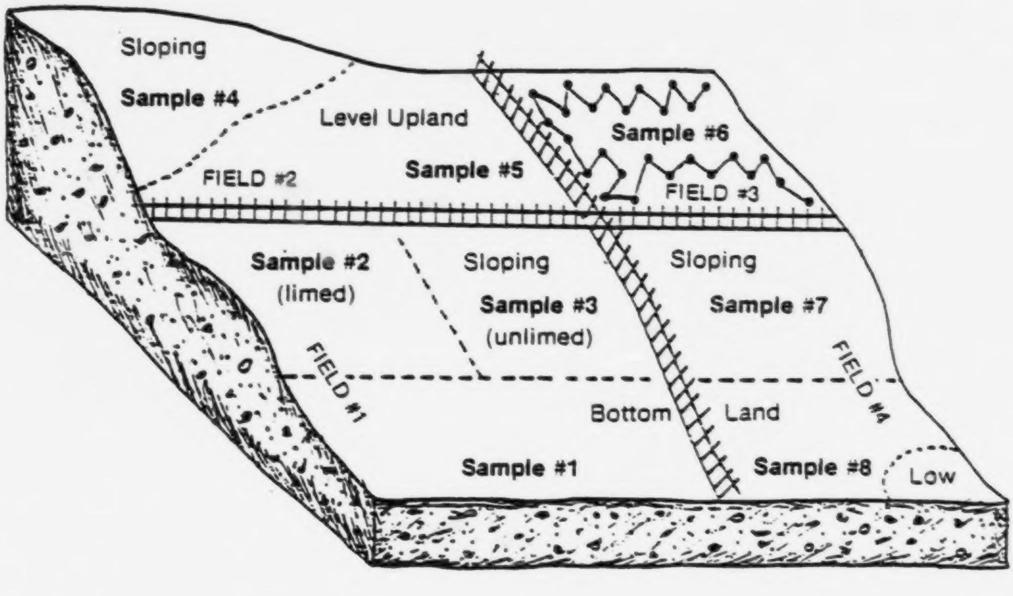

JOE'S
FERTILIZER
10-20-10
grade

Pattern for Obtaining Cores for a Soil Sample from One Field

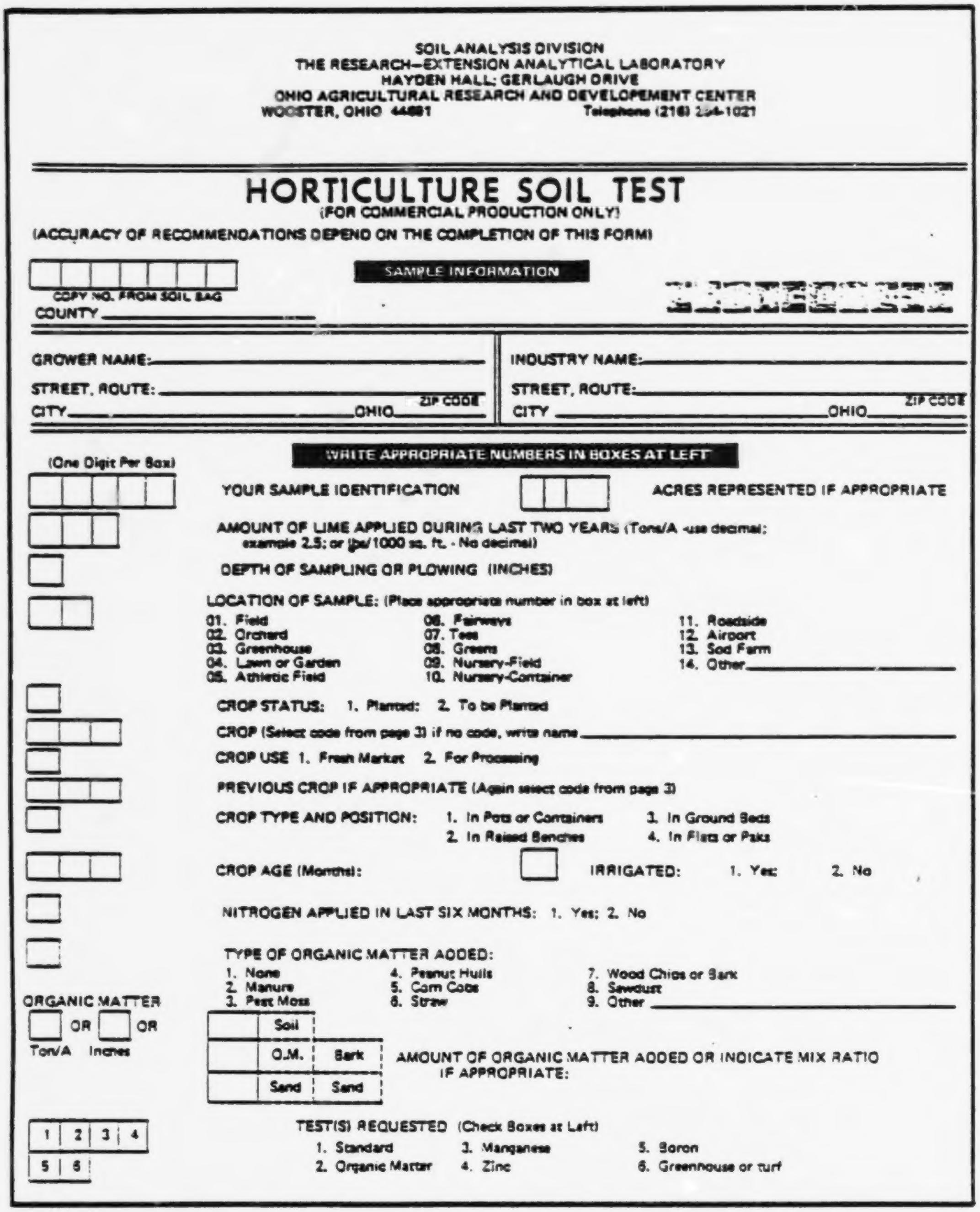

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27

196

Field Divided into Uniform Areas for Soil Testing


Sloping
Sample #4
Level Upland
Sample #6
FIELD #2
Sample #5
FIELD #3
Sample #2
(limed)
Sloping
Sample #3
(unlimed)
Sloping
Sample #7
FIELD #1
FIELD #4
Bottom
Land
Sample #1
Sample #8
Low

Sample Soil Test Information Sheet



SOIL ANALYSIS DIVISION
THE RESEARCH–EXTENSION ANALYTICAL LABORATORY
HAYDEN HALL; GERLAUGH DRIVE
OHIO AGRICULTURAL RESEARCH AND DEVELOPEMENT CENTER
WOOSTER, OHIO 44691 Telephone (216) 264-1021

HORTICULTURE SOIL TEST

(FOR COMMERCIAL PRODUCTION ONLY)

(ACCURACY OF RECOMMENDATIONS DEPEND ON THE COMPLETION OF THIS FORM)

SAMPLE INFORMATION

☐☐☐☐☐☐☐ COPY NO. FROM SOIL BAG

[illegible]

COUNTY ____________

GROWER NAME: ____________
STREET, ROUTE: ____________
CITY ____________ OHIO ____ ZIP CODE

INDUSTRY NAME: ____________
STREET, ROUTE: ____________
CITY ____________ OHIO ____ ZIP CODE

(One Digit Per Box)

WRITE APPROPRIATE NUMBERS IN BOXES AT LEFT

☐☐☐☐☐ YOUR SAMPLE IDENTIFICATION ☐☐☐ ACRES REPRESENTED IF APPROPRIATE

☐☐☐ AMOUNT OF LIME APPLIED DURING LAST TWO YEARS (Tons/A -use decimal; example 2.5; or lbs/1000 sq. ft. - No decimal)

☐ DEPTH OF SAMPLING OR PLOWING (INCHES)

☐☐ LOCATION OF SAMPLE: (Place appropriate number in box at left)

01. Field
02. Orchard
03. Greenhouse
04. Lawn or Garden
05. Athletic Field
06. Fairways
07. Tees
08. Greens
09. Nursery-Field
10. Nursery-Container
11. Roadside
12. Airport
13. Sod Farm
14. Other ____________

☐ CROP STATUS: 1. Planted: 2. To be Planted

☐☐☐ CROP (Select code from page 3) if no code, write name ____________

☐ CROP USE 1. Fresh Market 2. For Processing

☐☐☐ PREVIOUS CROP IF APPROPRIATE (Again select code from page 3)

☐ CROP TYPE AND POSITION: 1. In Pots or Containers 2. In Raised Benches 3. In Ground Beds 4. In Flats or Paks

☐☐☐ CROP AGE (Months): ☐ IRRIGATED: 1. Yes: 2. No

☐ NITROGEN APPLIED IN LAST SIX MONTHS: 1. Yes; 2. No

☐ TYPE OF ORGANIC MATTER ADDED:

1. None
2. Manure
3. Peat Moss
4. Peanut Hulls
5. Corn Cobs
6. Straw
7. Wood Chips or Bark
8. Sawdust
9. Other ____________

ORGANIC MATTER

☐ OR ☐ OR
Ton/A Inches

	Soil	
	O.M.	Bark
	Sand	Sand

AMOUNT OF ORGANIC MATTER ADDED OR INDICATE MIX RATIO IF APPROPRIATE:

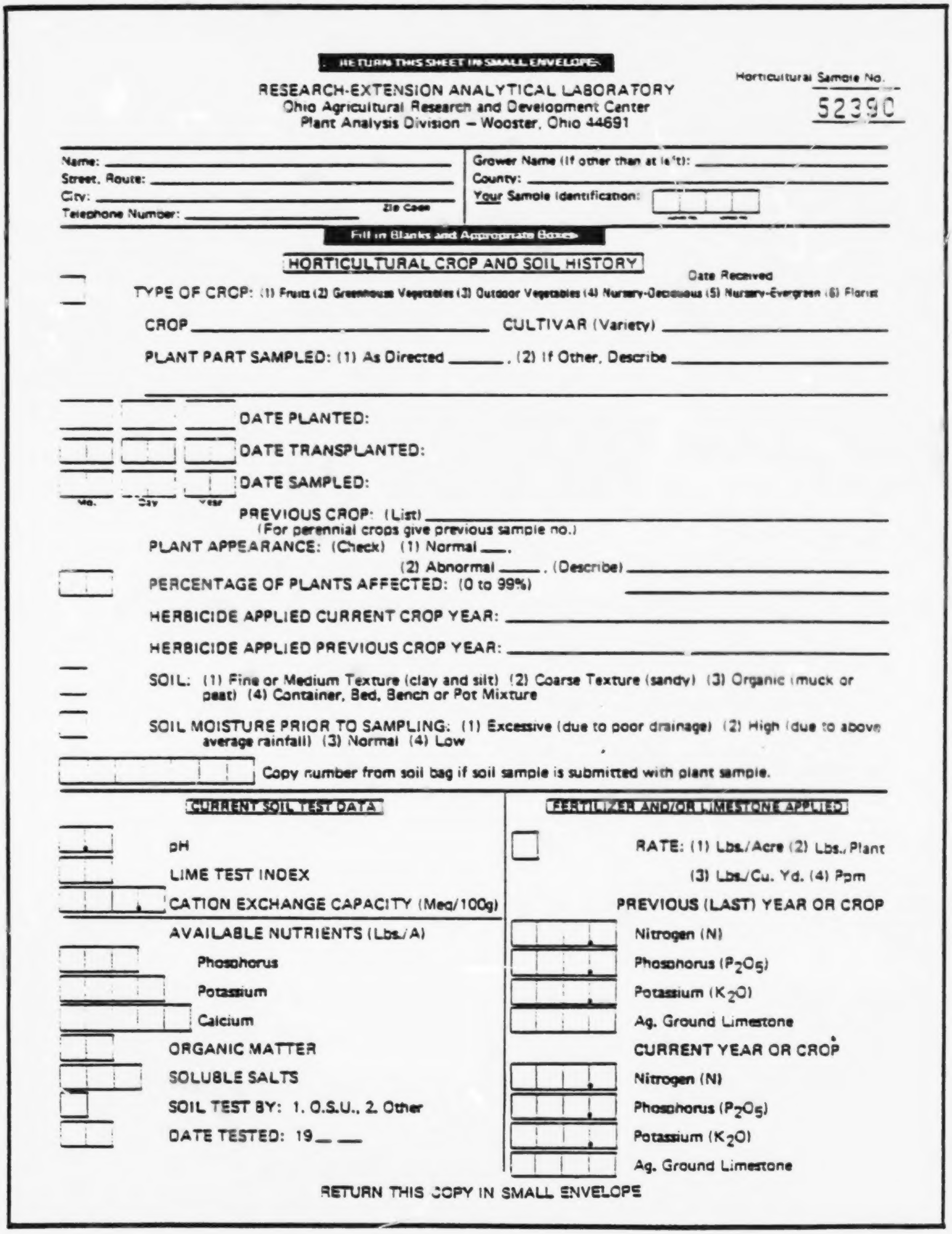
1	2	3	4
5	6		

TEST(S) REQUESTED (Check Boxes at Left)

1. Standard
2. Organic Matter
3. Manganese
4. Zinc
5. Boron
6. Greenhouse or turf

198

Sample Plant Analysis Form



RETURN THIS SHEET IN SMALL ENVELOPE

RESEARCH-EXTENSION ANALYTICAL LABORATORY
Ohio Agricultural Research and Development Center
Plant Analysis Division – Wooster, Ohio 44691

Horticultural Sample No. 52390

Name: ______
Street, Route: ______
City: ______ Zip Code
Telephone Number: ______

Grower Name (If other than at left): ______
County: ______
Your Sample Identification: ☐☐☐☐

Fill in Blanks and Appropriate Boxes

HORTICULTURAL CROP AND SOIL HISTORY

Date Received

☐ TYPE OF CROP: (1) Fruits (2) Greenhouse Vegetables (3) Outdoor Vegetables (4) Nursery-Deciduous (5) Nursery-Evergreen (6) Florist

CROP ______ CULTIVAR (Variety) ______

PLANT PART SAMPLED: (1) As Directed ______, (2) If Other, Describe ______

☐ ☐ ☐ DATE PLANTED:
☐ ☐ ☐ DATE TRANSPLANTED:
☐ ☐ ☐ DATE SAMPLED:
Mo. Day Year

PREVIOUS CROP: (List) ______
(For perennial crops give previous sample no.)

PLANT APPEARANCE: (Check) (1) Normal ___.
(2) Abnormal ___. (Describe) ______

☐ PERCENTAGE OF PLANTS AFFECTED: (0 to 99%) ______

HERBICIDE APPLIED CURRENT CROP YEAR: ______

HERBICIDE APPLIED PREVIOUS CROP YEAR: ______

☐ SOIL: (1) Fine or Medium Texture (clay and silt) (2) Coarse Texture (sandy) (3) Organic (muck or peat) (4) Container, Bed, Bench or Pot Mixture

☐ SOIL MOISTURE PRIOR TO SAMPLING: (1) Excessive (due to poor drainage) (2) High (due to above average rainfall) (3) Normal (4) Low

☐ Copy number from soil bag if soil sample is submitted with plant sample.

CURRENT SOIL TEST DATA

☐ pH
☐ LIME TEST INDEX
☐ CATION EXCHANGE CAPACITY (Meq/100g)
AVAILABLE NUTRIENTS (Lbs./A)
☐ Phosphorus
☐ Potassium
☐ Calcium
☐ ORGANIC MATTER
☐ SOLUBLE SALTS
☐ SOIL TEST BY: 1. O.S.U., 2. Other
☐ DATE TESTED: 19__ __

FERTILIZER AND/OR LIMESTONE APPLIED

☐ RATE: (1) Lbs./Acre (2) Lbs./Plant (3) Lbs./Cu. Yd. (4) Ppm

PREVIOUS (LAST) YEAR OR CROP
☐ Nitrogen (N)
☐ Phosphorus (P_2O_5)
☐ Potassium (K_2O)
☐ Ag. Ground Limestone

CURRENT YEAR OR CROP
☐ Nitrogen (N)
☐ Phosphorus (P_2O_5)
☐ Potassium (K_2O)
☐ Ag. Ground Limestone

RETURN THIS COPY IN SMALL ENVELOPE

CHAPTER 5

PLANT PROPAGATION METHODS

PERFORMANCE CHECK LIST

1. Describe various sources from which nursery operators can obtain seed for propagation.
2. Differentiate between stratification and scarification of seeds and describe each.
3. Describe three methods of scarifying seeds.
4. Explain how seeds are collected and stratified.
5. Describe and explain the various steps in seeding from seedbed preparation to maintenance of seedbeds or seed rows.
6. Describe four major uses of seedlings.
7. List the advantages of using cuttings for plant propagation.
8. Describe how to grow plants from stem cuttings, leaf cuttings, leaf-bud cuttings, and root cuttings.
9. Differentiate among hardwood, semi-hardwood, softwood, and herbaceous cuttings.
10. List and explain the aids in rooting cuttings.
11. Describe the process of grafting and explain the reasons for grafting.
12. Briefly explain the process of new cell growth that occurs after grafting.
13. Describe how to propagate plant by grafting, using one or more methods.
14. Differentiate between grafting and budding.
15. Describe how to propagate plants from budding using the shield or T-bud technique.
16. Describe the process of caring for plants after budding.

SUGGESTED LEARNING ACTIVITIES

1. Select three different trees or shrubs. Using references determine how to propagate these.

2. Have each student conduct a propagation project using three types of herbaceous plants. Take five cuttings of each variety and place each of these five cuttings in a different environment (i.e., bottom heat, no bottom heat, different growing media, different temperatures, etc.) Collect data regularly on these plants and compare the propagation rates.

3. Graft ten fruit trees using different grafting methods.

4. Have students stratify walnut seeds or other available seeds either naturally outside or by storing them in a refrigerator for planting at a later date.

5. Have students take cuttings of readily available and easily rooted woody plants such as forsythia. Stick the cuttings in media, care for them for several months (depending on variety), and check periodically for rooting.

6. Have students graft an English ivy to a Japanese fatsia using a cleft grafting procedure.

7. Visit a state nursery or local seed propagator. Observe their methods of cleaning, storing, and handling tree seeds.

8. Visit a local orchard and view the various kinds of grafts and buds on fruit trees. Compare the different methods, techniques or styles of grafts.

9. Take cuttings of plants on the school campus and keep records of the time cuttings are taken, conditions grown, and success. That is, keep a propagation log.

10. Stratify seeds of conifers and deciduous trees and shrubs. Then plant these seeds and record the results.

11. Propagate some easily rooted evergreens such as taxus.

12. Transplant seedlings or rooted cuttings to pots or nursery beds.

13. After reviewing the "Seed Propagation Chart," pages 89-92 of *The Nursery Worker*, select five different plants that can be easily propagated by seed and are common in your area. Collect and label the seeds while on "plant walks." Finally, plant these seeds and supply them with appropriate growing conditions.

14. After students have reviewed trade catalogs containing plant descriptions, have the students identify and list five grafted or budded plants common in the nursery trade.

15. If a misting system is available, have students draw diagrams of the system and label all the major parts.

SAMPLE INTEREST APPROACH

Bring in a pomato (sic) plant (root of potato, top of tomato) with fruits on the plant. You can wire the top to the bottom and cover up the union with your hand. Show your class the top part of the plant only. Ask what it is. Then show students the bottom of the plant. Ask how this can be.

Show a slide (or photo from a catalog) of an apple tree bearing apples of several colors. Ask how this can be.

Ask a student what would happen if you cut off a finger and stuck it in sand, watered it, etc. Will it grow a new hand? Then show a rooted mum cutting. Why does this work with plants and not with humans?

Show students a petunia seed, acorn, and coconut. These are all seeds. Are they all planted the same way? If not, why not?

Bring in a display of most kinds of sexual and asexual types of propagation. Why did these different ways work? Why aren't all plants propagated in the same way?

Give students the tools to graft a given plant. Tell them to do the grafting and report back when they are finished. When they admit they don't know how, ask them if they think it's important to know how. They'll see that it is.

NAME ____________________

KEY QUESTIONS FOR CHAPTER 5

PART 1

Seeding

1. What is plant propagation? (page 87)

2. Why do certain seeds need special treatment before planting? (page 88)

3. How does stratification differ from scarification? (page 88)

4. What is the most important step in seeding? (page 93)

5. Why do some nursery operators provide for seedbed irrigation? (page 93)

6. What are the two major methods of sowing seeds? (page 94)

7. Why do some nursery operators follow the practice of "hilling up" rows? (page 94)

8. Why is it important to space seeds properly? (page 94)

9. List three uses for seedlings. (pages 95-96)

NAME ____________________

PART 2

Cuttings

1. What is a cutting? (page 96)

2. Explain how hardwood, semi-hardwood, softwood and herbaceous cuttings are different. (pages 96-98)

3. What is a dibble? (page 99)

4. Name two plants often propagated by leaf cutting. (page 101)

5. Name two plants often propagated by leaf-bud cutting. (page 101)

6. What five factors are important in rooting cuttings? (page 102)

   1) ____________________
   2) ____________________
   3) ____________________
   4) ____________________
   5) ____________________
   6) ____________________

7. Name two materials often used as rooting media. (page 104)

NAME ____________________

PART 3

Grafting

1. What is grafting? (page 105)

2. Why are certain plants grafted? (page 105)

3. Why is compatibility important in grafting? (page 106)

4. Why is the cambium important in grafting? (page 106)

5. Under what circumstances would you use cleft grafting? (page 107)

6. How does cleft grafting differ from bench grafting? (pages 107-108)

7. For what group of plants is side grafting most often used? (page 110)

8. Under what circumstances would you use bark grafting? Why? (page 111)

NAME ______________________

PART 4

Budding and Layering

1. What is the difference between budding and grafting? (page 114)

2. What is budwood? (page 114)

3. Which budding technique is used most often in nurseries? (page 114)

4. Why is wrapping important in the budding operation? (pages 115-116)

5. What is layering? (page 117)

6. Why isn't layering used more often in nurseries? (page 117)

NAME ______________________

TERMS TO REMEMBER - Chapter 5

PART 1

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 5 of *The Nursery Worker*.

Technical Vocabulary

agar
air layering
budwood
dibble
dormant
drilling
explant
germicide
germinate
grafting
micropropagation
semi-hardwood cutting
somatic hybridization
stratification
understock

______________________ 1. The current season's growth from which single buds are removed. (page 114)

______________________ 2. A treatment used to break the dormancy of cold-requiring seeds. (page 88)

______________________ 3. Tissue culture. (page 122)

______________________ 4. Not in an active growing condition. (page 88)

______________________ 5. A pointed implement of wood, metal or plastic used to make holes in the soil when planting or transplanting. (page 99)

______________________ 6. Seeding in rows. (page 94)

______________________ 7. Cutting made from partially matured wood. (page 98)

______________________ 8. The rooted part of a plant to which the scion is grafted. (page 95)

______________________ 9. Implanting a scion from one plant into a growing plant, called the stock, so that their cambium layers contact each other enabling the plants to unite and grow together. (page 105)

______________________ 10. A gelatin-like product used for solidifying certain culture media. (page 123)

______________________ 11. To begin growth. (page 44)

______________________ 12. Production of roots above ground by use of special propagation techniques. (page 120)

______________________ 13. The plant part that is taken from a plant and placed in a culture medium. (page 123)

______________________ 14. The fusion of plant cells from incompatible species. (page 123)

______________________ 15. An agent for killing germs or microorganisms. (page 123)

NAME ____________________

TERMS TO REMEMBER - Chapter 5

PART 2

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 5 of *The Nursery Worker.*

Technical Vocabulary

budding
budstick
cultures
hardwood cutting
herbaceous cutting
in vitro culture
layering
liners
rootstock
scarification
scion
softwood cutting
tissue culture

____________________ 1. A method of propagation in which small sections of plant tissue are separated from the mother plant and grown independently. (page 122)

____________________ 2. A stem cutting made from mature wood. (pages 96-97)

____________________ 3. Young plants placed in rows in the field. (pages 127, 129)

____________________ 4. The insertion of a bud from one plant beneath the bark of another plant so that the cambium layers join and grow together. (pages 113-114)

____________________ 5. A cutting taken from a woody plant before new growth has hardened or matured. (page 98)

____________________ 6. Cuttings taken from leafy, succulent plants such as geraniums. (page 98)

____________________ 7. A stem or branch from which buds are removed in budding. (page 114)

____________________ 8. Grown on artificial media in test tubes or flasks. (page 122)

____________________ 9. A root and its associated growth buds, used as a stock plant in propagation. (page 105)

____________________ 10. A detached shoot or other part of plant consisting of one or more buds used in propagation by grafting. (page 106)

____________________ 11. A propagation method in which a part of the stem, shoot or branch is covered with soil or some other rooting medium. After rooting, the new plant is separated from the mother plant. (page 117)

____________________ 12. In micropropagation, the actively dividing tissues. (page 123)

____________________ 13. A method of scratching hard-coated seeds to weaken seed coats and thus hasten germination. (page 88)

Crossword Puzzle 5 Clues

ACROSS Clues

5. Burying plants or seeds in soil so they remain moist, but not warm enough to germinate. (page 88)
10. A young plant placed in a row in the field. (page 127)
11. The process of fusion of plant cells from incompatible species:- ______________ hybridization. (page 123)
12. The stem of a plant into which a graft is inserted. (page 106)
13. Another name for micropropagation is ______________ culture. (page 122)
16. The current season's growth from which single buds are removed for grafting. (page 114)
19. To sprout. (page 88)
20. A cutting taken from a woody plant before new growth has hardened or matured:- ____________ wood cutting. (page 98)
21. A propagation method in which plants produce roots above ground:- ____________ layering. (page 120)
22. Inserting a single bud from one plant into another plant. (page 114)

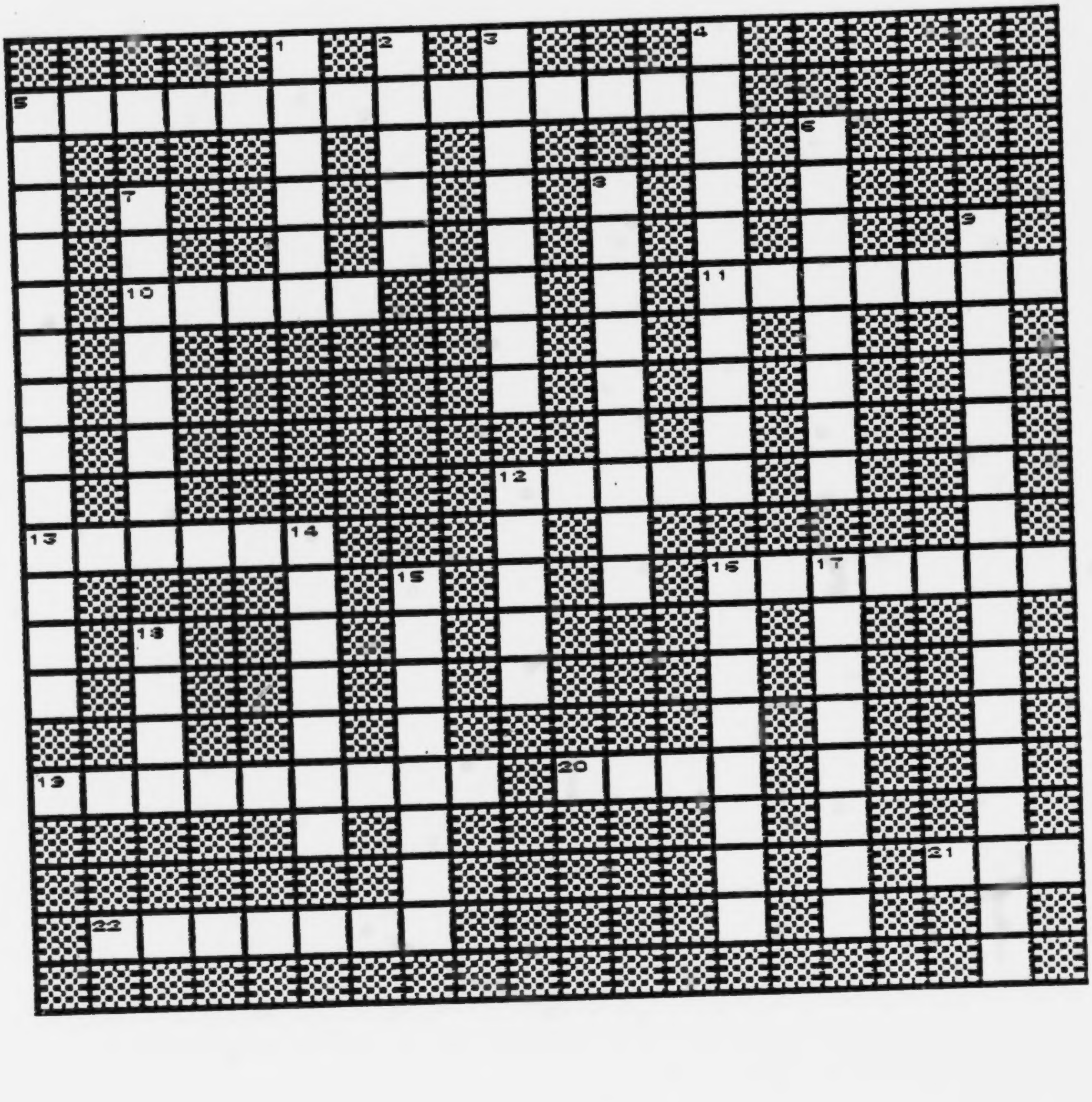
DOWN Clues

1. A sharp tool used to make holes in the soil when planting or transplanting. (page 99)
2. The growing of plantlets on artificial media in test tubes or flasks: — in ____________ culture. (page 122)
3. A propagation method in which a portion of the plant is covered with soil for rooting. (page 117)
4. The bottom part of a grafted plant. (page 95)
5. A method of scratching hard seed coats to hasten germination. (page 88)
6. A resting period for plants. (page 88)
7. In micropropagation, the actively dividing tissues. (page 123)
8. The part of a plant onto which a new variety has been grafted or budded. (page 106)
9. Another term for tissue culture. (page 122)
12. The top part of a grafted plant. (page 106)
14. The living tissue taken from a plant and placed in a culture medium. (page 123)
15. Joining a scion from one plant with another plant so that the two plant parts grow together. (page 105)
16. A stem from which buds are removed for use in budding. (page 114)
17. Seeding in rows. (page 94)
18. A gel-like substance used in micropropagation (page 123)

NAME ______________________

CROSSWORD PUZZLE 5

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in the *The Nursery Worker.*


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

NAME ____________________

LETTER MAZE 5-A

The 20 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
Y X R L Z H H O T Y R Z I H U R O O T S T O C K S T A L Y
S R T W X O S Q T O Z U E V U E X V P D I R H Q Y C N T R
G G H L G P L N K C X J R O F U O N O N T U G V J H I Z L
U I G E Z Y H G L U C L Q P H C K K M T C B H V Q O D O J
U J O T F E E J I X X D O Z P C E O I Y P V T G X Z I K N
I Q L H W Y R G U B S G W R I E T I T S W A R U A E I S I
C C B A B K B W E H U C V T N U S C C O O A U Y Y Q W C P
H L O K G S A Y C R O D S K B I L J X V Y F H K C Z Q A N
F V M I D E C K R E M D O W A B V W K W I Q T P V V D R G
A Q D G E H E R Q L U I L I A G A Q S V O A M W R O A I X
U B B G B D O P S B O S N A N M G S C O R Z C P O O P F P
T H X H D S U H S V I T C A Y G V R M I E U D K A O T I F
G R E U P I S C C R D R E V T E A R W T W B O G V V D C G
A W G J Q Y S O Z Q D A K W G E R O Y T T Y R J A E X A W
K M Q R N A D V B K I T F J V H X I F V E C M E C R P T B
L Y A X T X Z Z U G B I S H D H X S N G Z G A E G T K I Y
W X U H L S F C X P B F F C R Q Y K Y G R G N T Q M R O B
Q X L V R A L M O F L I D L I E X P L A N T T Y X J G N J
L X M E L A P B H K E C G Y L D L K B I S U R M S I L G P
I Y N H O U O V I D K A Y S L D Z Z T H H F W N J F M I X
P I D U S T A T I K X T A Y I T Y F Y F R A P J I T Y Q Z
L O I T L G N J O D I I P X N V A T J L J O R E W N L W H
B V G X T K D A H Y V G V U G R Y J H K H H D D W S A D C
T X I N B F H X H V K N C O G E B W L C Z I J I W S H O I
O R U S B W P F O E U N D E R S T O C K C A G A R O Z I P
N M V E U D C Y F O U L O R C B X J D I M Z Y Z M I O X U
E E E H H I S W V J U H B M N T C L M P W P Z E J M W D J
J H W Q S O S W Y S M O D K G R G R U Y W O J X F V F E W
A V M B N K M L X M S K I W P P E K K O A I O R F H H K Y
S P I K B T Y G P Z Q V T O U G T O E R D H A K E O M R A
```

AGAR
BUDDING
BUDSTICK
DIBBLE
DORMANT
DRILLING
EXPLANT
GERMICIDE
GERMINATE
GRAFTING
HARDWOOD
HERBACEOUS
LAYERING
LINERS
ROOTSTOCK
SCARIFICATION
SCION
SOFTWOOD
STRATIFICATION
UNDERSTOCK

NAME ____________________

LETTER MAZE 5-B

The 20 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
X U E E X E D R V P G D X S Q Z S C T Y X R L Z H H L E X O T
R Z I H U T A L Y S R T W X O S T T S L Q T O Z U E V U E X V
D I R H Q Y N T R G G H L G P L L S R U N K C X J R O F U O N
N T U G V J H Z L U I G E Z Y S S U G A L U C L Q P H C K M T
B H V Q O D J U J O T F E C T Q J I X X T D O Z P E O I Y P V
G X Z I K I Q L H W Y J K M A U S G W R E I T I T W E A R U A
I I C C B A B K U J K W H C G V E N U S C C F O A L U Y Y Q W
H L O K G S K I O Y C O K B A I L X J X V Y H I B K C Z Q N F
M I D E Y G F K R E W A B V R W K W P I Q P V B C V D G A Q D
E H J H E R Q L A G A Q S V O A M R O L A X I U B A B G B D D
L J P S O M G S L C O R Z C P O D P P T A D H X H D T S Q E O
H S V I C V R G M A I E U K A T R B F G G N R E U P I I S R R
C C R D E V N A R W Y T W B G K I U L V V E T G A W S G O J M
Y S N U J I O Z Q K W E N G C O L D I Y T T R Y J A T E X N A
K M Q R T N A D B R R O R I V B L D N K F J V M H X O F V E N
E C R F P B L Y A X I T T I X Z I I E L V A Z U I G C S H H T
S G A Z G E G T K T Y S W R N X N N R U H L F O Y N K P C X P
C R Q Y K Y R T A Q D M R B O G G G Q X L V A L N H A Y M O F
G L Y X J G J C L U X M L A P O W W G B H K G Y D L K T B S U
M S I L G P I I B Y H O U O F O T W V I D K Y S D Z Z H E F W
J F M I X F P D U S T A R C O T I S K X A K Y T Y Y F R P J I
Y Q Z O I I T L G N X R A J O D I P T X C V T J L J O W N L W
B V G R X T K D P F C A H Y V V U Y J O H K H H W S A D C T X
N B A F H X D H X H V K C O E B H W T L C C Z J I N S H O I O
U C S B W P M J J F O E Z I P N A S M V E K U D O C I K Q Y F
S U L O R C B X J D M Z Y Z G E R M I C I D E I M I X U E E E
H I S M Z T W V J U H B M N T E D C L P W P C Z E J M W J J H
Q S O S H E R B A C E O U S D C W F G W Y S S M O D K G R G U
W O J X F V F E W A V M B N N K O M E F M L X M S K I W P P K
O A I O R F H H K Y S P U I K B O T Y K N X G P Z Q V T O U T
E R D H A K E O M R A M M R J J D K C S L A N N E P N A Z F L
```

AGAR
BUDDING
BUDSTICK
DIBBLE
DORMANT
DRILLING
EXPLANT
GERMICIDE
GERMINATE
GRAFTING
HARDWOOD
HERBACEOUS
LAYERING
LINER
ROOTSTOCK
SCARIFICATION
SCION
STOCK
STRATIFICATION
UNDERSTOCK

NAME ____________________

STUDENT EXERCISE 5-A

DETERMINING SEED GERMINATION AND SEED VIGOR

Following are suggested procedures to use for determining seed germination and seed vigor. These tests can be conducted individually or as a classroom activity. A form is included (page 5-16) to be used for filling in data collected from these tests.

MATERIALS:

- a supply of seeds of typical horticultural crops (or use corn, soybean, oat and wheat seeds). If all four crop seeds are tested at the same time, comparisons can be made regarding time required for germination and appearance of the seedling. The amount of seeds required depends on the number of seeds used in the test (10, 20, 50, or 100) and the number of tests planned.
- a roll of paper towels or strips of absorbent cloth 12 inches wide and 12 to 36 inches in length. (The length of cloth strips can be determined by the number of seeds to be tested.)
- a bucket, tub, or other suitable container to hold the paper or cloth rolls containing the seeds.

A. THE WARM GERMINATION TEST

PROCEDURE:

1. Select a predetermined number of seeds to be tested (10, 20, 50, or 100).
2. Place the seeds about an inch apart between moistened layers of paper towels or cloths.
3. Roll up the moistened towels or cloths and place in a suitable container. Keep rolls moist throughout the test period and the temperature at 60-70° F (15.6 - 21.1° C).
4. If more than one lot of seed of the same kind is to be tested, mark each roll with an identifying number or letter.
5. Check each roll for germination after three days. Count and record the number of seeds that show root or stem sprouts or both. Repeat the above procedure after five days.
6. At the end of seven days, count all seeds showing strong stem and root sprouts.
7. Calculate the germination percentage by dividing the number of germinated seeds by the total number used in the test (and multiplying by 100).

CONCLUSIONS:

From your observations, write your conclusions concerning the germination capabilities of the seed and its desirability for use in planting.

B. THE PRIMARY ROOT LENGTH TEST

PROCEDURE:

1. From any warm germination test (completed in seven days), count the number of seeds showing the longest primary roots. With crop seeds such as corn and soybeans, only primary roots over one inch in length are counted.
2. Calculate the percentage by dividing the number of seeds showing the longest primary roots by the total number of seeds in the test (and multiplying by 100).

CONCLUSIONS:

Observe the results of the test and make your conclusions.

(continued)

C. THE COLD TEST

MATERIALS:

- about one gallon of seed-starting media for each test.
- a roll of heavy-duty paper towels (made specifically for germination tests) or strips of absorbent cloth 12 inches wide and 2-4 feet long.
- seeds - the number used depending on the number needed for the test. If a comparison between warm germination and cold tests is to be made, the seeds for both tests should come from the same lot.
- a refrigerator where the temperature can be kept at 50° F (10° C).

PROCEDURE:

1. Select the seeds to be tested.
2. Place the seeds on the paper towels or cloth strips about one inch apart. Sprinkle the moistened planting media over the seeds, barely covering them. Cover the seed and soil mixture with another paper towel and roll up. Place in a suitable container and keep rolls moist throughout the test period.
3. For one week, place the seed and media in a refrigerator set at 50° F (10° C).
4. Remove from the refrigerator to a warmer area of 65-70° F (18.3-21.1° C) for one week to permit germination.
5. Count the germinated seeds and make the same calculations as described with the warm test.

CONCLUSIONS: Observe the results of the test and make your conclusions.

D. THE T Z TEST

MATERIALS:

- a supply of seeds. For comparison purposes, seeds from the same lots used in the warm and cold germination tests should be used.
- a small supply of the chemical 2, 3, 5-triphenyl tetrazolium chloride. (This can be obtained from the Seed or Crop Improvement Association of your state. If not, the Association can provide you with information as to a source of supply.)

PROCEDURE:

1. Soak seeds in warm water at a temperature of 85-100° F (29.4-37.8° C) for about two hours. (A longer period will do no harm.) This soaking will soften the seeds and activate the enzymes inside them.
2. Cut the seeds to be tested lengthwise through the center to expose the full length of the germ. Seeds are easily cut with a sharp single-edged safety razor blade.
3. Place halves of the sectioned seeds in a 1.0% solution of TZ. Then warm the solution to 85-100° F (29.4-37.8° C) or leave at room temperature - 75° F (23.9° C). Leave the seed halves in the solution - two hours at 85-100° F, or four hours at 75° F.
4. Remove the seed halves from the solution and examine with a magnifying lens for color changes. All actively respiring parts of the germ become red or deep pink. The endosperm and all dead parts of the germ do not change in color. When the entire germ of the seed turns red, the seed is alive and capable of germinating.

CONCLUSIONS: Observe the results of the test and make your conclusions.

EVALUATION:

1. The experiments were conducted as directed. ______________
2. The chart was filled in accurately and neatly. ______________
3. All materials used were cleaned and put away neatly. ______________

FINAL GRADE ________

(continued)

DATA SHEET FOR GERMINATION TEST RESULTS

KIND OF SEED AND LOT NO.	WARM TEST			PRIMARY ROOT LENGTH TEST			COLD TEST			T Z TEST		
	Number of Seeds In Test	Number Germinated	%	Number of Seeds In Test	Number With Longest Root Length	%	Number of Seeds In Test	Number Germinated	%	Number of Seeds In Test	Number of Seeds Red Staining	%

NAME ____________________

STUDENT EXERCISE 5-B

EFFECTS OF LIGHT ON SEEDLING GROWTH

The following is a simple experiment to show the assimilation of foods through photosynthesis and the use of foods by respiration.

MATERIALS:

- 300 seeds
- scales
- two seed flats with enough soil to plant 100 seeds
- a 20- or 40-watt fluorescent lamp as a source of light if sunlight is not available where the experiment is to be conducted. (A combination of one cool white tube and one warm white tube works well.)

PROCEDURE:

1. Divide the 300 seeds into three lots of 100 seeds each.

   Lot A - Dry out one lot of seeds and weigh them.

   Lot B - Plant the second lot of seeds in a seed flat. Keep moist in the dark at 68-72° F (20-22.2° C) for three weeks.

   Lot C - Plant the third lot of seeds in a seed flat. Keep moist at 68-72° F (20-22.2° C). Expose this seed flat to sunlight or fluorescent light for three weeks.

2. At the end of the three-week period, remove the seedlings from the soil flats of Lots B and C using care to obtain all of the seedlings including the roots. Wash all the soil from the seedlings. Dry them as was done with the seeds of Lot A. Weigh the dry material from the two Lots B and C.

3. Record all the information in the following chart.

Lot	Environment	Dry Weight of Seeds	Dry Weight of Seedlings	Difference in Weight of Seedlings
A	None			
B	Without light			
C	With light			

CONCLUSIONS:

Write your conclusions as a result of this experiment.

EVALUATION:

1. Experiments were conducted as directed. ______________
2. The chart was completed neatly and accurately. ______________
3. All materials and equipment used were cleaned and put away neatly. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 5-C

MEASURING WATER LOST BY TRANSPIRATION

The following activity measures transpiration (loss of water) from a plant. Most of the water loss from plants occurs through the stomata of the leaves. The amount of water lost can be measured. Also the differences in amount lost under different environmental conditions can be determined.

MATERIALS:

- a growing plant in a container, or a plant growing in a convenient location
- plastic bag or sheet of clear plastic to cover the plant or a branch of the plant with 10 to 12 leaves
- string, rubber bands, or other suitable tying materials
- stake to support weight of plastic
- plastic straw or other suitable tubing for a drain
- measuring cup or beaker

PROCEDURE:

1. Be sure the plant has been watered.
2. Cover the entire plant or a section of the plant with plastic (Figure 5-1).
3. Locate the tubing at bottom of plastic covering to serve as a water drain.
4. Place plant in sunny location for one day. At sunset measure the water collected. Empty container.
5. Measure water collected during dark period of the day.
6. Compare the difference in the amount of water collected.

QUESTIONS:

Which part of the day produced the most water in the container? Why?

____

____

EVALUATION:

1. The experiment was conducted as directed. ____________
2. The questions were answered correctly. ____________
3. All materials used were cleaned and put away neatly. ____________

FINAL GRADE ________

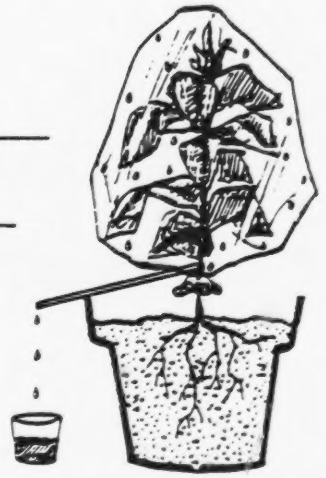


Figure 5-1. Measuring transpiration in a plant.

NAME ______________________

STUDENT EXERCISE 5-D

SEED COLLECTION AND STRATIFICATION

In nature seeds fall to the ground and become covered by soil and leaves. Rain during winter keeps them moist, and cold temperatures "treat" them. In spring some of these seeds germinate. Nursery operators must simulate these conditions to germinate certain seeds. The purpose of this exercise is to familiarize you with typical procedures used in this process.

MATERIALS:

- seeds
- small wooden box
- moist sand
- polyethylene to cover box
- jar with lid

PROCEDURE:

1. Place a layer of the moist sand 2-3 inches deep in the bottom of the box.
2. When you have identified the seeds, place a layer of the seeds on top of this sand layer. Don't use all of the seeds. Save about half of them.
3. Cover the seeds with another layer of moist sand.
4. Wrap the box in polyethylene. Consult the chart on pages 89-92 of *The Nursery Worker Student Manual* to determine the proper storage temperature as well as the time required in storage.
5. Attach a card to this box with the following information written on it:

   Species of seed
   Date placed in storage
   Temperature required
   Date to be removed from refrigeration
   Name of student

6. Place the box in cold storage at the proper temperature.
7. Properly label the other half of the seeds. Place them in an airtight container and store in a cool, dark room. Plant both groups of seeds after the proper stratification period has elapsed. Observe the germination.

QUESTIONS:

Which group of seeds germinated best — those stratified in moist sand or those stored in the jar? Why?

____

____

____

EVALUATION:

1. The experiment was conducted as directed. ____________
2. The questions were answered correctly. ____________
3. All materials and equipment used were cleaned and stored properly. ____________

FINAL GRADE ______

NAME ____________________

STUDENT EXERCISE 5-E

HARDWOOD-DECIDUOUS CUTTINGS

Hardwood-deciduous cuttings are considered the least expensive of the cuttings to produce. These cuttings are also easy to propagate. The purpose of this exercise is to familiarize you with procedures used in rooting this type of cutting.

MATERIALS:

- pruning shears
- source of cuttings from willow, poplar, and/or grape plants
- moist sand or peat moss
- plastic bag
- wire twists

PROCEDURE:

1. Review the section "Hardwood-Deciduous Cuttings," pages 96-97 of the Student Manual.
2. Obtain 10 to 20 cuttings of the proper length from each plant — willow, poplar, and grape.
3. Bundle cuttings properly. Label them appropriately.
4. Place each bundle in moist medium in plastic bag. Tie bag to maintain moisture content.
5. Place plastic bag in refrigerator and maintain temperature between 33 and 40° F (0.6–4.4° C).
6. Once the danger of frost has passed, plant cuttings in the field making sure that the basal end is down. Follow instructions in the section "Planting Stem Cuttings," page 99.

QUESTIONS:

1. Why is it important to maintain proper moisture content for the cutting bundles?

____

____

2. Why is it necessary for the cuttings to be stored at cool temperatures?

____

____

3. Why is it important to make sure that you plant cuttings with the basal end down?

____

EVALUATION:

1. Cuttings were taken as directed. ____________
2. Cuttings were stored as directed. ____________
3. Cuttings were planted properly. ____________
4. Questions were answered accurately. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 5-F

SOFTWOOD CUTTINGS*

Softwood cuttings are taken from soft new growth of deciduous or evergreen plants in early spring. This type of cutting will root more quickly than other types. However, it requires more care and specialized equipment. The purpose of this exercise is to familiarize you with procedures used in propagating these cuttings.

MATERIALS:

- pruning shears or knife to secure cuttings
- softwood cuttings
- hormone rooting powder
- misting apparatus over greenhouse bench
- cutting flats and peat pots

PROCEDURE:

1. Review the section "Softwood Cuttings," page 98 of the Student Manual.
2. Obtain 10-20 cuttings of the proper length from as many different plants as feasible, depending upon the time of year this exercise is conducted.
3. Treat half of the cuttings of each species with rooting powder. Do not treat the other half. Properly label each group. Record the data on the following chart (page 5-22).
4. Plant half of the treated cuttings in a greenhouse bench or flats. Plant the other half by direct sticking into peat pots. Do the same for the untreated cuttings. Properly label each group. Record the data on the following chart.
5. Place the cuttings under the misting apparatus in the greenhouse to insure a high level of humidity during the root-forming period.
6. Check the cuttings after *two weeks, three weeks*, and *four weeks* to see if they have rooted. To do this, try to lift a cutting gently from the growing medium. If it tends to pull out very easily, stop pulling, as the roots have not formed adequatey. If it is difficult to pull out of the medium, roots have probably become established.
7. At the end of four weeks, pull up one or two of each cutting and compare the root growth on the treated and the untreated cuttings. Sketch the comparable cuttings and their root formation in the space provided on the following chart.

EVALUATION:

1. Cuttings were taken as directed. ____________
2. Cuttings were planted as directed. ____________
3. The chart and sketches were completed neatly and accurately. ____________
4. All materials and equipment used were cleaned and stored properly. ____________

FINAL GRADE ________

(continued)

**Note:* This exercise will take careful planning. Softwood cuttings are taken from actively growing plants, usually in June and July. If plants are actively growing in May, students can attempt to secure adequate cuttings from most broadleaf plants for use during this month. If it is not desirable to wait until May to conduct this exercise, the student may attempt to use ivy or similar cuttings during the fall or winter months.

SOFTWOOD CUTTINGS

Type of Cutting	Date Taken	Rooting Medium	Treatment	Rooting Progress		
				2 weeks	3 weeks	4 weeks
		Bench or Flat	Treated Untreated			
		Peat Pot	Treated Untreated			
		Bench or Flat	Treated Untreated			
		Peat Pot	Treated Untreated			
		Bench or Flat	Treated Untreated			
		Peat Pot	Treated Untreated			
		Bench or Flat	Treated Untreated			
		Peat Pot	Treated Untreated			

SKETCH

NAME ____________________

STUDENT EXERCISE 5-G

BENCH GRAFTING (DECIDUOUS PLANTS)

The bench graft is one of the most popular grafting methods and therefore one of the most important. Bench grafting gets its name from the fact that the grafting is usually done on a bench. The stock and scion are brought into the work room or greenhouse. Cleft and bark grafts are performed on stocks growing in place. The purpose of this exercise is to familiarize you with procedures used in bench grafting.

MATERIALS:

- apple seedlings (or other seedlings if apple are not available)
- scions from apple trees or flowering crabapples (or scions that are compatible with other seedlings used)
- moist sphagnum moss
- box for storage
- sharp grafting knife
- rubber strips or twine
- grafting wax

PROCEDURE:

1. Prepare your working area for the grafting procedure. Provide for melting the grafting wax and have the necessary materials within reach.
2. Follow the procedure outlined for bench grafting (pages 108-110 of the Student Manual). (Also see Figure 5-2.)
3. Place the completed grafts in moist sphagnum moss and store in a temperature of 75-80° F (23.9-26.7° C) for a week or ten days to allow for callusing. If the grafts are to be stored after callusing has taken place, they can be placed in the refrigerator under conditions similar to those for dormant scions being stored until ready for planting.

QUESTIONS:

1. Why are grafts stored at warm temperatures for a week or so?

____

____

2. What would happen if the grafts were immediately placed in the refrigerator?

____

____

____

EVALUATION:

1. Grafts were properly made. ____________
2. Grafts were properly stored. ____________
3. Questions were answered correctly. ____________

FINAL GRADE ________

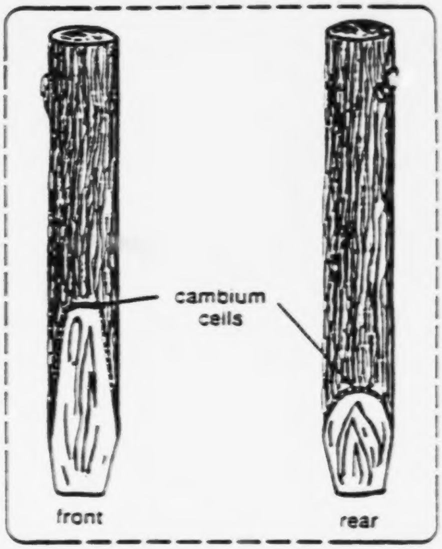


Figure 5-2. Exposure of cambium cells with both cuts on a scion.

22A

NAME ____________________

STUDENT EXERCISE 5-H

SIDE GRAFTING (EVERGREENS)

The side graft is a popular type of graft used for evergreens. The name implies where the graft is made — on the side. As with other grafting, different procedures are used by different nurseries. The following exercise will familiarize you with one of these procedures.

MATERIALS:

- juniper seedlings potted in the soil
- desired juniper scions
- sharp grafting knife
- twine

PROCEDURE:

1. Prepare your working area for the grafting procedure.
2. Follow the procedure outlined for side grafting (pages 110-111 of the Student Manual).
3. Place the potted grafts under conditions of high humidity and a bottom heat of 68-72° F (20-22.2° C) until callusing occurs in two or three weeks. Gradually harden up the callus formation with a gradual reduction of heat and head back the plant in one or two operations before planting out in beds.

QUESTIONS:

1. Why is high humidity needed during the callusing period?

   ____

   ____

2. What would happen if the heat were not reduced gradually and the plants were not headed back before planting out in beds?

   ____

   ____

EVALUATION:

1. Grafts were properly made. ____________
2. Grafted plants were stored properly. ____________
3. All materials and equipment used were cleaned and stored properly. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 5-I

BUDDING

Budding is a procedure in which a bud from one plant is united with another plant in such a way that the two parts will continue to grow. The purpose of this exercise is to familiarize you with some of the typical budding procedures used in commercial nurseries.

MATERIALS:

- apple, peach, locust or other seedlings growing in the field.
- budsticks from compatible varieties
- sharp grafting or budding knife
- rubber strips

PROCEDURE:

1. Depending upon the type of plant to be budded, follow the appropriate technique for budding out in the field. (Review Student Manual pages 114-116.)
2. Follow through the growing season on cutting back the top of the plant above the bud.

QUESTION:

Why is it necessary to cut back the top of a budded plant?

____

____

EVALUATION:

1. Plants were properly budded. ____________
2. Plants were properly cut back. ____________
3. All materials and equipment were cleaned and properly stored. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 5-J

COMPOUND LAYERING

Compound layering is sometimes referred to as **serpentine layering.** It is used to propagate flexible shoots like the Muscadine grape, and ornamental vines such as wisteria and clematis. The purpose of this exercise is to familiarize you with this procedure.

MATERIALS:

- greenhouse bench
- wisteria, clematis, or a similar vine that will root readily in the greenhouse
- knife for wounding

PROCEDURE:

1. Review "Compound Layering," page 119 of the Student Manual.
2. Prepare the medium in the greenhouse bench for the layering procedure.
3. Wound the vine between the leaves on the side of the stem that will become the underside after the stem is covered with soil mixture.
4. Cover the parts of the stem similar to the stem shown in Figure 5-3.
5. Water the rooting medium and care for the layered plant until new roots have become established and the new plants can be cut away from the mother plant.

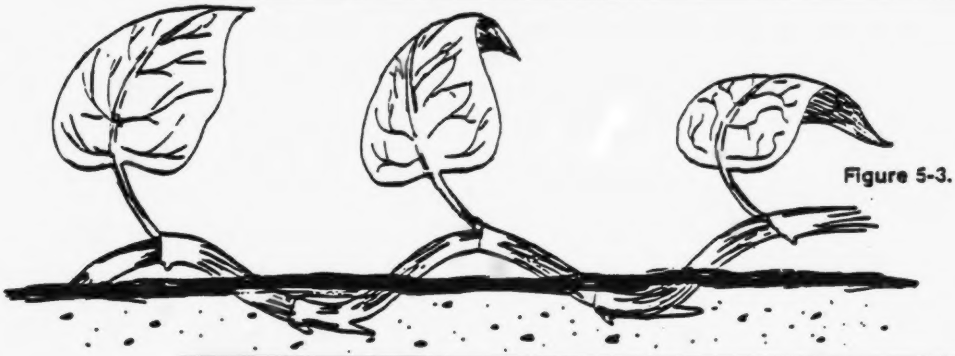


Figure 5-3. Compound layering

QUESTIONS:

1. Why is it necessary to wound the plants to be layered?

____

____

2. Why are layered plants kept moist?

____

____

EVALUATION:

1. Plants were layered as directed. ____________
2. All materials and equipment used were cleaned and properly stored. ____________

FINAL GRADE ________

NAME ______________________

QUIZ - CHAPTER 5

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. Some seeds need a period of cold temperature to break their dormancy.

T F 2. Nurseries which have soils that crust heavily often sow seed by broadcasting.

T F 3. In seedbeds, hilling up insures adequate moisture and protects the seed.

T F 4. Planting seeds too close results in competition between the plants for moisture and nutrients.

T F 5. A scion is the rooted part of a plant onto which the top part of another plant is grafted or budded.

T F 6. A cutting is any part of a root, stem leaf, or bud which is separated from the plant.

T F 7. Cuttings are generally very costly to produce.

T F 8. Hardwood deciduous cuttings are the most costly and difficult cuttings to produce.

T F 9. Hardwood narrow-leaved evergreen cuttings are usually much slower to root than are deciduous cuttings.

T F 10. Softwood cuttings generally require very little humidity.

T F 11. Herbaceous cuttings require both high humidity and controlled bottom heat for proper rooting.

T F 12. A dibble is a tool used to make holes into which cuttings or seedlings are inserted.

T F 13. Many deciduous trees are propagated by leaf cutting.

T F 14. Plants like black raspberry, blackberry, camellia, lemon, and rhododendron are often propagated by leaf bud cutting.

T F 15. Use of hormones generally results in faster rooting of cuttings.

T F 16. Wounding of the stem can be an aid in rooting certain cuttings.

T F 17. Some plants will not produce true-to-type offspring from seed.

T F 18. Compatibility is an unimportant factor to consider when grafting two plants together.

T F 19. The cambium is the active, growing area where new cells form.

T F 20. Cleft grafting is usually associated with topworking.

T F 21. The side graft is a popular type of graft used for evergreens.

T F 22. The bark graft is sometimes used in place of the cleft graft in topworking.

T F 23. The budwood is the current season's growth from which single buds are removed for budding.

T F 24. The shield or T-bud is rarely used in nurseries.

T F 25. Wrapping helps prevent drying out of newly budded plants.

T F 26. Layering is the most common propagation method used by commercial nurseries in the United States.

(continued)

QUIZ - page 2

T F 27. Tissue culture requires large pieces of the stock plant.

T F 28. Tissue culture is always the most costly method of propagation.

MULTIPLE CHOICE

Read each item and decide which choice correctly completes the statement or answers the question. Circle the letter of your choice.

29. Pretreatment of seeds by storing them in a moist substance is called:

A. scarification
B. stratification
C. hibernation
D. imbibition

30. Drilling is the practice of:

A. sowing seeds in rows
B. scarification
C. an irrigation method
D. covering seed rows with a mound of soil

31. Young plants planted in rows in the field are called:

A. understocks
B. liners
C. budlings
D. air layers

32. Which of the following groups of plants is typically propagated by semi-hardwood cuttings?

A. deciduous trees
B. deciduous shrubs
C. broadleaf evergreens
D. narrowleaf evergreens

33. Which of the following factors is important for successful propagation of nursery stock?

A. heat
B. hormones
C. humidity
D. all of the above

34. Which of the following is **rarely** used as a rooting medium for herbaceous or softwood cuttings?

A. field soil
B. sharp sand
C. peat
D. vermiculite

35. Plants are grafted to:

A. repair certain types of damage to trees
B. take advantage of benefits from certain rootstocks
C. reduce the time needed to grow seedlings for breeding programs or other purposes
D. accomplish all of the above

36. Whip grafting is another name for:

A. cleft grafting
B. bark grafting
C. bench grafting
D. side grafting

37. Which of the following is needed for propagation by layering?

A. a healthy, well-established mother plant
B. well-drained, friable soil
C. proper watering
D. all of the above

38. Serpentine layering is another name for:

A. tip layering
B. mound layering
C. compound layering
D. air layering

(continued)

QUIZ - page 3

39. Which of the following is **not** an advantage of propagation by tissue culture?

    A. In most cases the mother plant is not destroyed.
    B. A single piece of plant tissue can produce thousands of plants in less than one year.
    C. Tissue culture can be done anywhere with no special equipment needed.
    D. Tissue culture is sometimes the least costly propagation method.

40. With which of the following methods of propagation would you most likely require sterile conditions?

    A. micropropagation
    B. bark grafting
    C. budding
    D. layering

41. Treating seeds with the proper temperatures to promote rapid germination is . . .

    A. scarification
    B. dormancy
    C. stratification
    D. propagation

42. Hardwood deciduous cuttings are usually taken during the . . .

    A. dormant season
    B. spring (April-May)
    C. summer (June - August)
    D. plant's first year of growth

43. Compatibility refers to . . .

    A. the ability to graft two plants together based on how closely related they are
    B. the relationship between the xylem and phloem
    C. the scion
    D. the rootstock

44. The cells responsible for the rootstock and scion growing together are called . . .

    A. scion cells
    B. cambium cells
    C. xylem cells
    D. phloem cells

45. Budding generally is done in . . .

    A. spring
    B. summer
    C. fall
    D. winter

ANSWER KEY - CHAPTER 5

Key Questions, Part 1 - page 5-4

SEEDING

1. Plant propagation can be defined as the controlled reproduction of plants.
2. Certain seeds require special conditions similar to those in nature in order to germinate. For example, some seeds need a cold dormancy treatment. Others need a period of moist storage to germinate.
3. Stratification is pretreatment of seeds by storing them in a moist substance at carefully controlled temperatures. Scarification is any process used to modify hard seed coats.
4. The most important step in seeding is preparation of the seedbed or seed row.
5. Some nursery operators provide seedbed irrigation because their soils do not have adequate moisture-holding capacity.
6. The major methods of sowing seeds are broadcasting and drilling.
7. "Hilling up" insures adequate moisture and protects the seed.
8. If seeds are not spaced properly, they may compete with each other for nutrients and moisture. This will result in a crop of weak, poor-growing seedlings.
9. Three uses for seedlings are understocks, liners and direct sale.

Key Questions, Part 2 - page 5-5

CUTTINGS

1. A cutting is any part of a root, stem, leaf, or bud which is separated from the plant.
2. *Hardwood cuttings* are taken during the dormant season from a shoot of the previous season's growth. They are the least expensive cuttings to produce.

   Semi-hardwood cuttings are taken from shoots of plants that have recently experienced an active growth period. The wood is partially matured.

   Softwood cuttings are taken from soft, new growth of plants in early spring. This type of cutting will root more quickly than other types.

   Herbaceous cuttings are taken from leafy, succulent greenhouse plants such as geraniums.
3. A dibble is a tool used to make a hole for cuttings.
4. Sansieveria (snake plant), African violet, and rex begonia can be propagated by leaf cuttings.
5. Raspberry, blackberry, camellia, lemon and rhododendron can be propagated by leaf bud cuttings.
6. The following factors are important in rooting cuttings: heat, hormones, wounding, growing medium, and humidity.
7. Materials often used as rooting media include: vermiculite, sharp sand, and peat and sand.

Key Questions, Part 3 - page 5-6

GRAFTING

1. Grafting is uniting part of one plant with another plant in such a way that the two parts continue to grow.
2. Some plants are grafted because they will not reproduce true-to-type seeds. Other plants are grafted because they do not readily produce good root systems when cuttings are made.

(continued)

Answers *(continued)*

3. Compatibility is important in grafting because plants that are not related cannot be grafted. Only related plants can be grafted.
4. The cambium is important in grafting because this layer is made up of actively dividing and living cells. When you graft part of one plant on another plant, the main objective is to line up the cambium layers. They must join and grow together if the plant is to continue to grow as one plant.
5. Cleft grafting is usually used when topworking — with a trunk or branch that is 1 to 2 inches in diameter.
6. Bench grafting is usually done on a bench. (The plant is brought to the work area.) Cleft grafts are performed on stocks growing in place.
7. Side grafting is often used for evergreens.
8. Bark grafting can be used instead of the cleft graft in topworking. It is sometimes preferred because it does not split the stub.

Key Questions, Part 4 - page 5-7

BUDDING

1. Budding is a form of grafting in which the bud from one plant is united with a part of another plant in such a way that the two unite and grow as one.
2. Budwood is the current season's growth from which buds are removed for budding.
3. Nurseries commonly use the shield or T-bud.
4. Wrapping is important because the grafted plant is growing in the field. The only protection this bud will have against drying out is the wrapping.

LAYERING

5. Layering is defined as placing a growing mother plant in a horizontal or slightly inclined position and putting a layer of soil over a part of its stem. This encourages formation of roots on the stem.
6. Layering isn't often used in nurseries because it is a slow process requiring skilled attention.

Terms to Remember, Part One - page 5-8

1. budwood
2. stratification
3. micropropagation
4. dormant
5. dibble
6. drilling
7. semi-hardwood cutting
8. understock
9. grafting
10. agar
11. germinate
12. air layering
13. explant
14. somatic hybridization
15. germicide

Terms to Remember, Part Two - page 5-9

1. tissue culture
2. hardwood cutting
3. liners
4. budding
5. softwood cutting
6. herbaceous cutting
7. bud stick
8. in vitro culture
9. rootstock
10. scion
11. layering
12. cultures
13. scarification

Crossword Puzzle - page 5-11

ACROSS

5. stratification
10. liner
11. somatic
12. stock
13. tissue
16. budwood
19. germinate
20. soft
21. air
22. budding

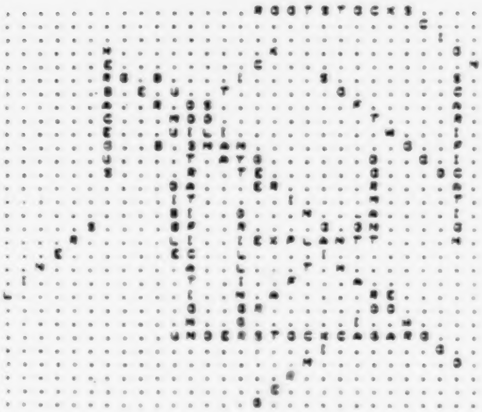
DOWN

1. dibble
2. vitro
3. layering
4. understock
5. scarification
6. dormancy
7. cultures
8. rootstock
9. micropropagation
12. scion
14. explant
15. grafting
16. budstick
17. drilling
18. agar

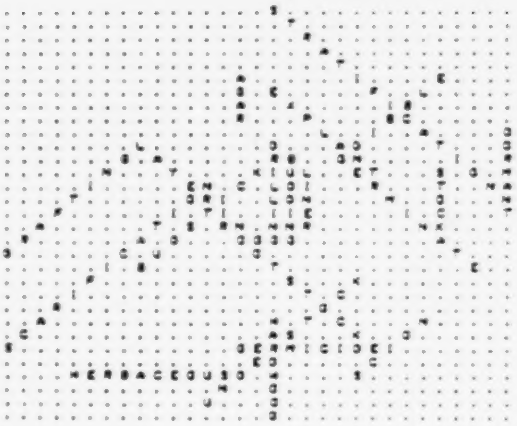
(continued)

Answers *(continued)*

Letter Maze 5-A - page 5-12



Letter Maze 5-B - page 5-13



QUIZ

True or False - page 5-27

1. true
2. true
3. true
4. true
5. false
6. true
7. false
8. false
9. true
10. false
11. true
12. true
13. false
14. true
15. true
16. true
17. true
18. false
19. true
20. true
21. true
22. true
23. true
24. false
25. true
26. false
27. false
28. false

Multiple Choice - page 5-28

29. B
30. A
31. B
32. C
33. D
34. A
35. D
36. C
37. D
38. C
39. C
40. A
41. C
42. A
43. A
44. B
45. A

GLOSSARY - Chapter 5

agar - a gelatin-like product used for solidifying certain culture media in micropropagation.

air layering - a special propagation technique used with certain plants; it produces roots above ground.

budding - the insertion of a bud from one plant beneath the bark of another plant so that the cambium layers join and grow together to form a new plant.

budstick - a stem or branch from which buds are removed in budding.

budwood - also known as budstick. The current season's growth from which single buds are removed.

cultures - in micropropagation, the actively dividing tissues.

dibble - a pointed implement of wood, metal, or plastic used to make holes in the soil when planting or transplanting.

dormant (noun - **dormancy**) - not in active growing condition. Capable of resuming growth when environmental conditions are favorable.

drilling - seeding in rows.

explant - the living material taken from an animal or plant and placed in a culture medium.

germicide - an agent for killing germs or microorganisms.

grafting - implanting a scion from one plant into a growing plant called the stock. The cambium layers contact each other enabling the scion to derive water and nutrients from the stock. This eventually results in a union of the two parts.

hardwood cutting - stem cutting made from the mature wood of either a deciduous plant or a narrow-leaved evergreen.

herbaceous cuttings - cuttings taken from leafy, succulent plants such as geraniums.

in vitro culture - growing plants on artificial media in test tubes or flasks.

layering - a propagation method in which a part of a stem, shoot, or branch is covered with soil or some other rooting medium. After rooting has taken place, the new plant is separated from the parent plant.

liners - young plants grown in rows in the field.

micropropagation - tissue culture. Referred to as "micropropagation" because only small pieces of the stock plant are used.

rootstock - a root and its associated growth buds. Used as a stock plant in propagation.

scarification - a method of scratching hard-coated seeds to weaken seed coats and thus hasten germination.

scion - a detached shoot or other portion of a plant consisting of one or more buds. Used in propagation by grafting.

semi-hardwood cutting - shoot of plant that has recently experienced active growth period. The wood is partially matured.

softwood cutting - cutting taken from a woody plant before new growth has hardened or matured.

somatic hybridization - fusion of plant cells from incompatible species.

(continued)

Glossary *(continued)*

stratification - 1) the storage of seeds between layers of earth, leaves, or other material. 2) burying seeds to keep them fresh and moist, but not so warm as to germinate. 3) treatment used to break the dormancy of cold-requiring seeds.

tissue culture - method of plant propagation in which small sections of plant tissue are separated from the mother plant and grown independently.

understock - the rooted part of a plant to which the scion is grafted.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 5

T5-1 *(Student Manual*, page 88)

Stratification is the pretreatment of seeds by storing them in a moist substance at carefully controlled temperatures. This pretreatment conditions the seeds for rapid germination the following spring.

Question: What are some types of seeds which require stratification?

T5-2 *(Student Manual*, pages 95-96)

Nursery operators may use seedlings as liners, understocks, and potted understocks, or for direct sale.

Question: What is a liner? An understock?

T5-3 *(Student Manual*, pages 96-98)

Nursery operators may use different types of cuttings depending upon the type of plant to be propagated.

Questions: How do hardwood, semi-hardwood, softwood and herbaceous cuttings differ? What are some of the plants typically propagated by leaf cuttings? Leaf-bud cuttings? Root cuttings?

T5-4 *(Student Manual*, pages 96-97)

Hardwood-deciduous cuttings are generally 4 to 12 inches long. At least two nodes are included. The bottom cut is made just below a node, and the top cut is made ½ to 1 inch above the node.

Questions: Why are hardwood-deciduous cuttings generally inexpensive to produce? When are these cuttings usually taken? How are these cuttings stored?

T5-5 *(Student Manual*, page 98)

Semi-hardwood cuttings are taken from plants that have recently experienced an active growth period. The wood is partially matured.

Question: What group of plants is typically propagated by semi-hardwood cuttings?

T5-6 *(Student Manual*, page 99)

A **dibble** is needed to make a hole in the ground for cuttings. Cuttings can be injured if they are simply stuck into the soil. Also, if a rooting hormone was used on the cutting, this compound will be rubbed off if the cutting is forced into the soil.

T5-7 *(Student Manual*, pages 99-100)

Rooting hormone can hasten rooting with certain types of cuttings.

T5-8 *(Student Manual*, pages 99-100)

After dipping the cuttings in rooting hormone, insert them carefully into the rooting medium. Place them far enough apart so there is very little overlapping of leaves.

Question: Why is it important that the leaves do not overlap?

Narratives for Transparency Masters *(continued)*

T5-9 *(Student Manual*, pages 99-100)

A 2" x 4" can be used to measure the distance to the next slit for cuttings. This 2" x 4" also presses the medium around the cuttings that were previously planted and provides straight, equally spaced lines.

T5-10 *(Student Manual*, page 101)

Leaf cuttings consist of a leaf blade, or a leaf blade and petiole. In most cases the leaf cutting does not become part of the new plant. For the sansevieria cutting shown here only a portion of a leaf has been used as the cutting.

Question: What are some other plants propagated by leaf cutting?

T5-11 *(Student Manual*, page 101)

New plants can be obtained from plants such as rex begonia by removing a leaf blade and petiole from the parent plant. The entire leaf is then held down so that the midrib or leaf margins touch the moist medium. Leaf veins are cut on the undersurface before they are placed on the medium. Once these plants have established a root system, they are transplanted into pots.

Question: What special conditions are required for this type of propagation?

T5-12 *(Student Manual*, page 102)

Large roots are generally propagated outdoors. These cuttings are from 2 to 6 inches long. They are made in late fall or early winter. Cuts are made to identify the proximal and distal ends of the cuttings. The cuttings are then tied into bundles, packed in moist material, and stored like hardwood cuttings until spring.

Question: How are cuttings of small roots made?

T5-13 *(Student Manual*, pages 102-104)

These factors can aid in rooting cuttings.

Questions: Why is heat important? How can it be provided? How do hormones affect the cuttings? Why are some cuttings wounded? How does the growing medium affect rooting? Why is humidity important during propagation?

T5-14 *(Student Manual*, page 104)

Wounding is the process of making a light cut near the bottom of a cutting. This procedure may stimulate the formation of roots, particularly when the wounding is used along with hormone treatments.

Question: What happens if the cut or wound is too deep?

T5-15 *(Student Manual*, pages 105-113)

Grafting is one of the most interesting methods of plant propagation. It involves uniting part of one plant with another plant in such a way that the two parts will continue to grow.

Question: Why are plants grafted?

Narratives for Transparency Masters *(continued)*

T5-16 *(Student Manual*, pages 106-107)

When you graft part of one plant on another plant, the main objective is to line up the cambium layers. They must join and grow together if the plant is to continue to grow as one plant. This figure shows how cambium growth takes place.

T5-17 *(Student Manual*, pages 111-112)

This figure illustrates the proper preparation of the scion. A single cut is made about 1½ inches long on one side of the loose end. This makes one part of the scion wedge-shaped. A short sloping cut about ½ inch long is then made on the opposite side of the stem from the longer cut. It forms a beveled end on the scion.

Questions: Why do some grafters prefer to use a bark graft rather than a cleft graft? When is most bark grafting done? Why?

T5-18 *(Student Manual*, pages 111-113)

The cambium layer is exposed for the entire length of the cut. This cambium layer will then be in direct contact with the cambium cells located directly beneath the bark peeled back on the stock.

Question: Why is bark grafting often more successful than cleft grafting?

T5-19 *(Student Manual*, pages 111-113)

In method 1 a single cut is made into the bark. The bark on both sides of the cut is slightly separated from the wood. The scion is pushed downward just under both cuts. Finally, the scion and two bark flaps are nailed to keep the scion in place. In method 2 only one flap is cut. In method 3 the prepared scion is held in place on the outside of the bark with tacks or brads.

T5-20 *(Student Manual*, pages 110-111)

The side graft is a popular type of graft used for evergreens.

T5-21 *(Student Manual*, pages 117-121)

Layering is defined as placing a growing mother plant in a horizontal or slightly inclined position and putting a layer of soil over part of its stem. This encourages formation of roots on the stem.

Question: Why don't more commercial nurseries use layering as a propagation method?

T5-22 *(Student Manual*, page 118)

The first requirement for simple layering is a properly grown, healthy, well-established mother plant.

Question: Why is it important to pinch the mother plants?

T5-23 *(Student Manual*, page 118)

In simple layering the mother plant is heeled-in, or planted at an angle.

Narratives for Transparency Masters *(continued)*

T5-24 *(Student Manual*, page 118)

A stem from the mother plant is sharply bent, pegged to the ground, and covered with soil.

Question: Why is the buried portion of the stem sharply bent?

T5-25 *(Student Manual*, page 118)

This figure illustrates the final step in the process of simple layering. After layering is completed, proper watering and weed control are the major concerns of nursery operators.

Question: How long will it be before the new plants can be cut away from the mother plant?

T5-26 *(Student Manual*, page 119)

Compound layering is sometimes referred to as **serpentine layering**. It is used to propagate flexible shoots like Muscadine grape, wisteria, and clematis.

T5-27 *(Student Manual*, pages 119-120)

Mound layering is used for plants with branches too stiff to bend. The mother plant is cut back so new shoots develop at the base. Once these new shoots are 3 to 5 inches tall, the soil is mounded around them to about half their height. When they have reached a height of 8 to 10 inches, soil is again mounded around the roots up to about half their height.

Question: How long does it take before these new shoots can be separated from the mother plant?

T5-28 *(Student Manual*, pages 120-121)

In trench layering the mother plant is transplanted into a row at an angle of 30 to 45°. It is allowed to grow for one year. Before spring growth begins the following year, the plant is pegged down in the bottom of the trench. The shoots are cut back slightly to initiate bud growth. Soil is then added periodically to cover the base of the shoots that are starting to develop.

Question: For what type of plants is trench layering recommended?

T5-29 *(Student Manual*, pages 122-124)

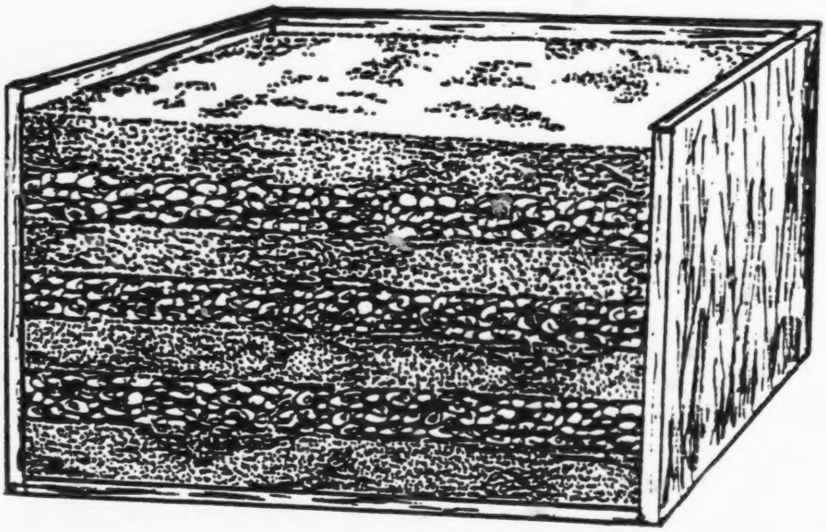
For tissue culture, you should choose a part of the plant that has cells that readily divide. Almost any actively growing part will work.

Question: Why is tissue culture of plants important to nursery operators?

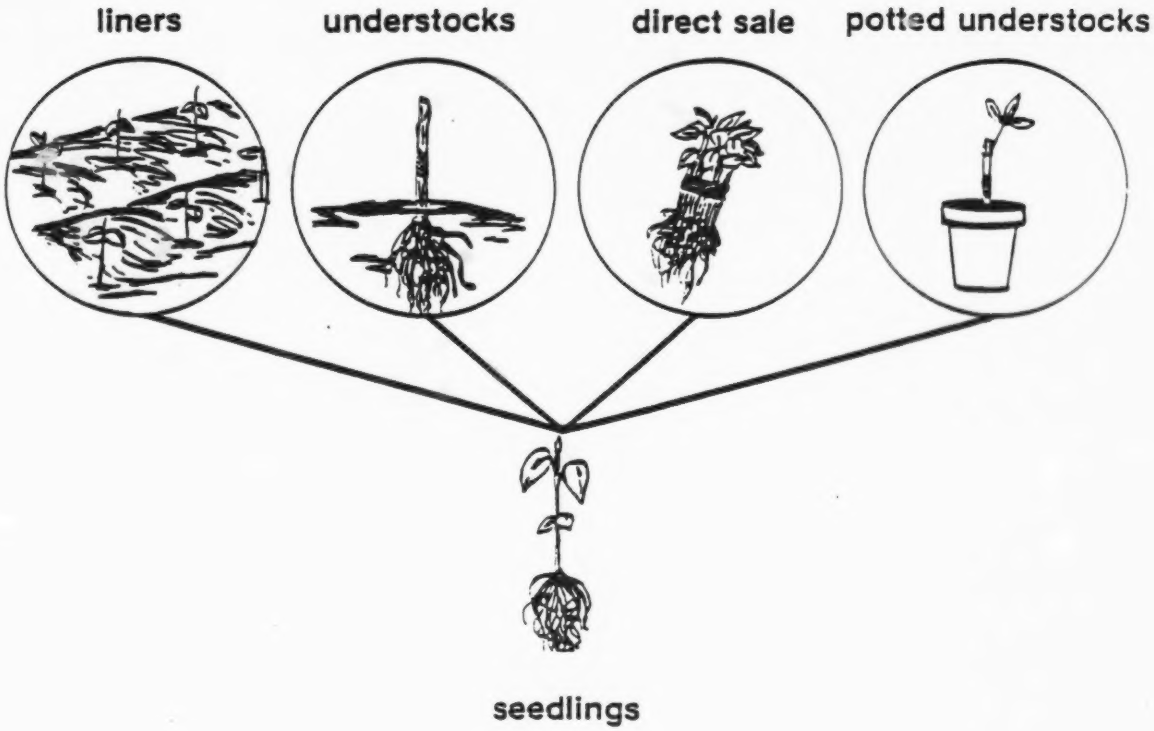
T5-30 *(Student Manual*, pages 122-124)

For tissue culture of many woody plants the elongating shoot tips are used.

Side View of Seeds Being Stratified in Moist Sand



Uses of Seedlings


liners
understocks
direct sale
potted understocks
seedlings

Types of Cuttings

A. Stem cuttings

  1. Hardwood
    a. Deciduous
    b. Narrow-leaf evergreen

  2. Semi-hardwood

  3. Softwood

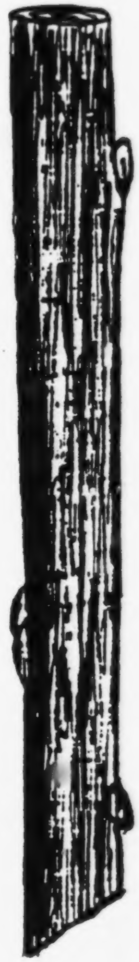
  4. Herbaceous

B. Leaf cuttings

C. Leaf-bud cuttings

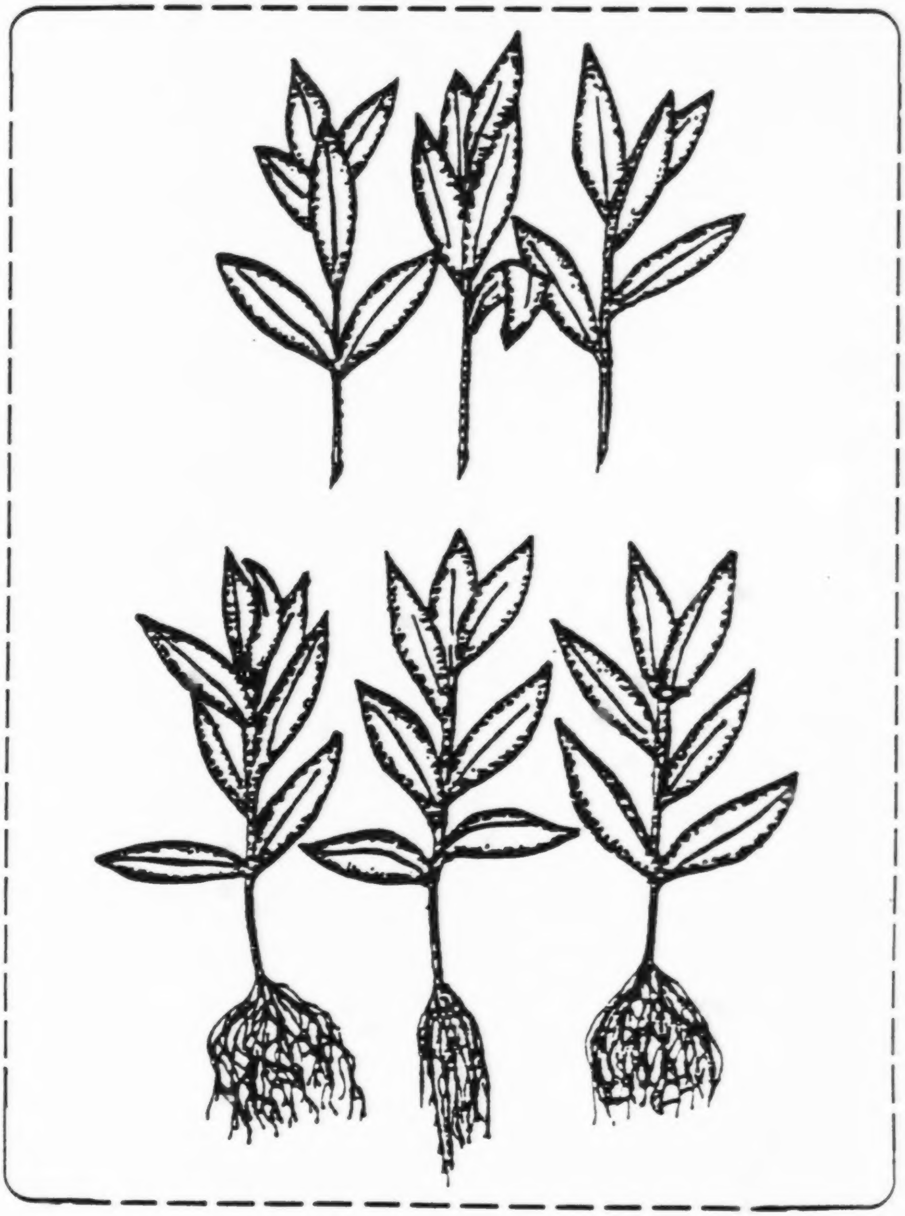
D. Root cuttings

Hardwood-Deciduous Cutting Showing Proper Locations of Cuts



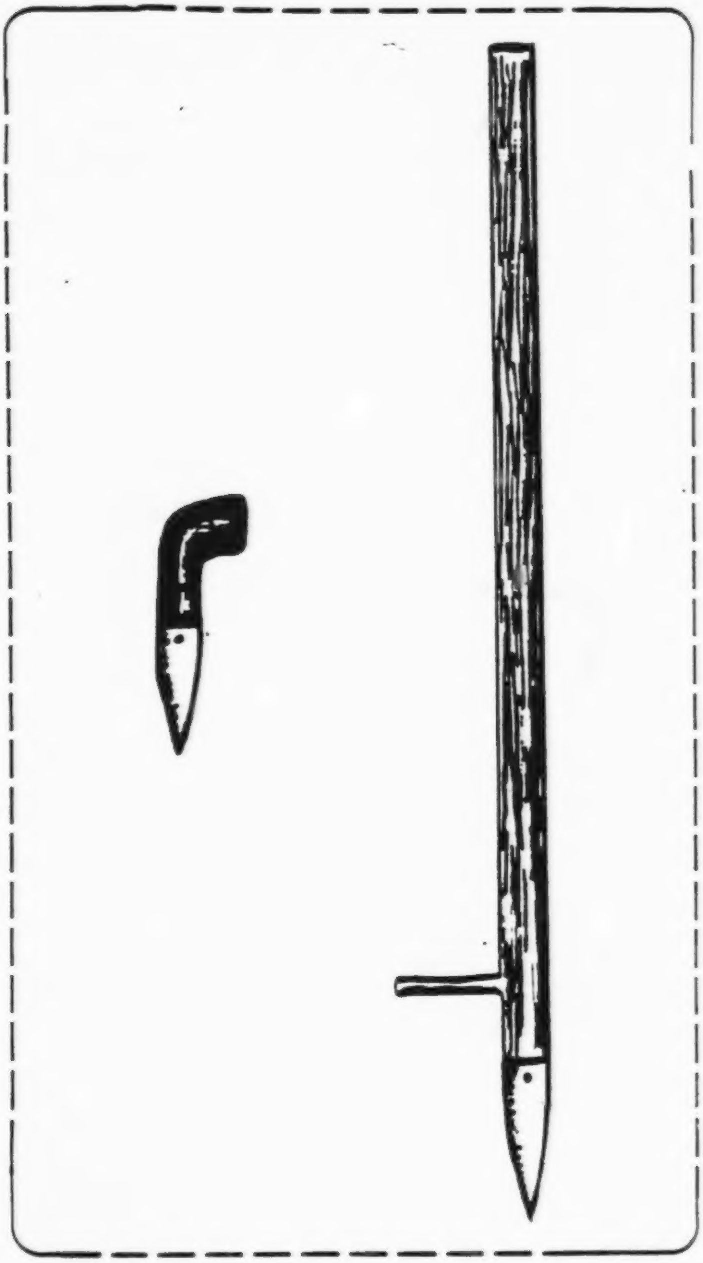
243

Semi-Hardwood Cuttings

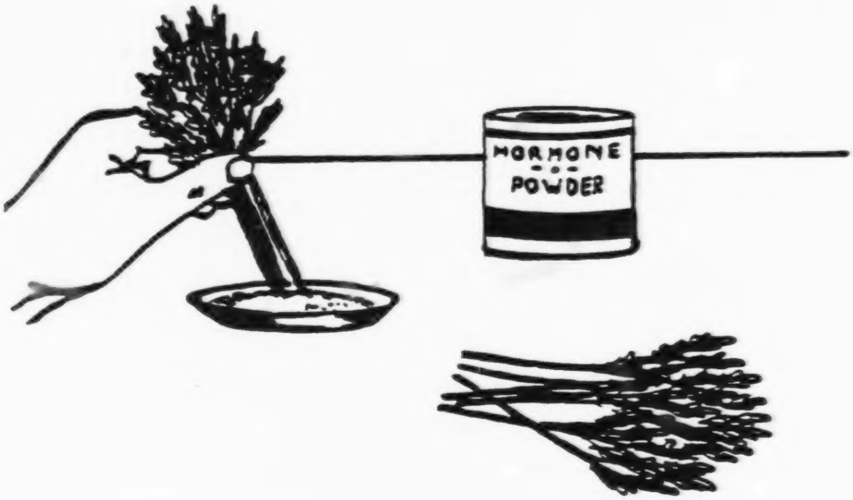


T5-6

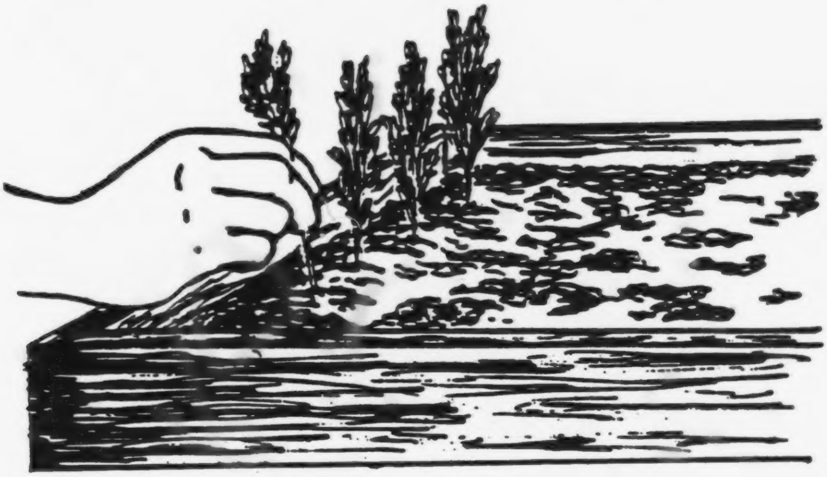
Two Sizes of Dibble Used for Making a Hole for a Cutting



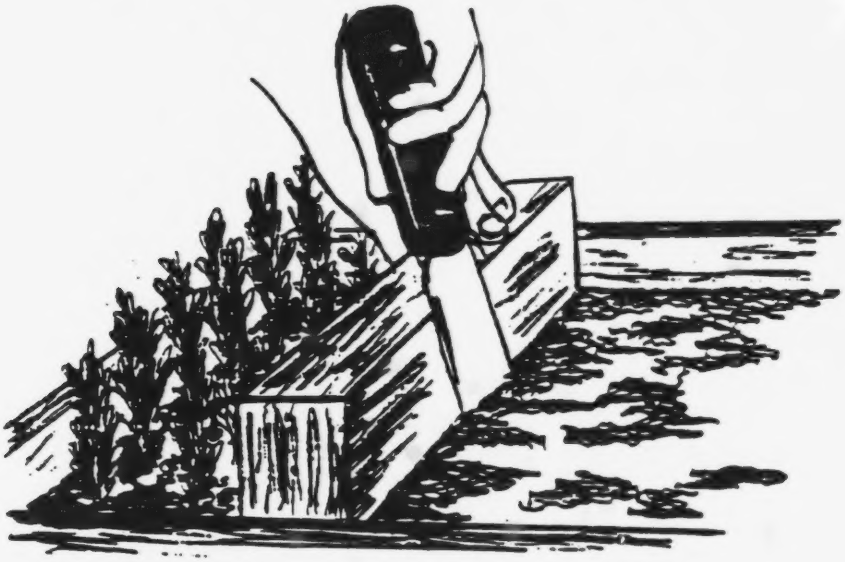
Dip Cutting Ends in Rooting Hormone


HORMONE
POWDER

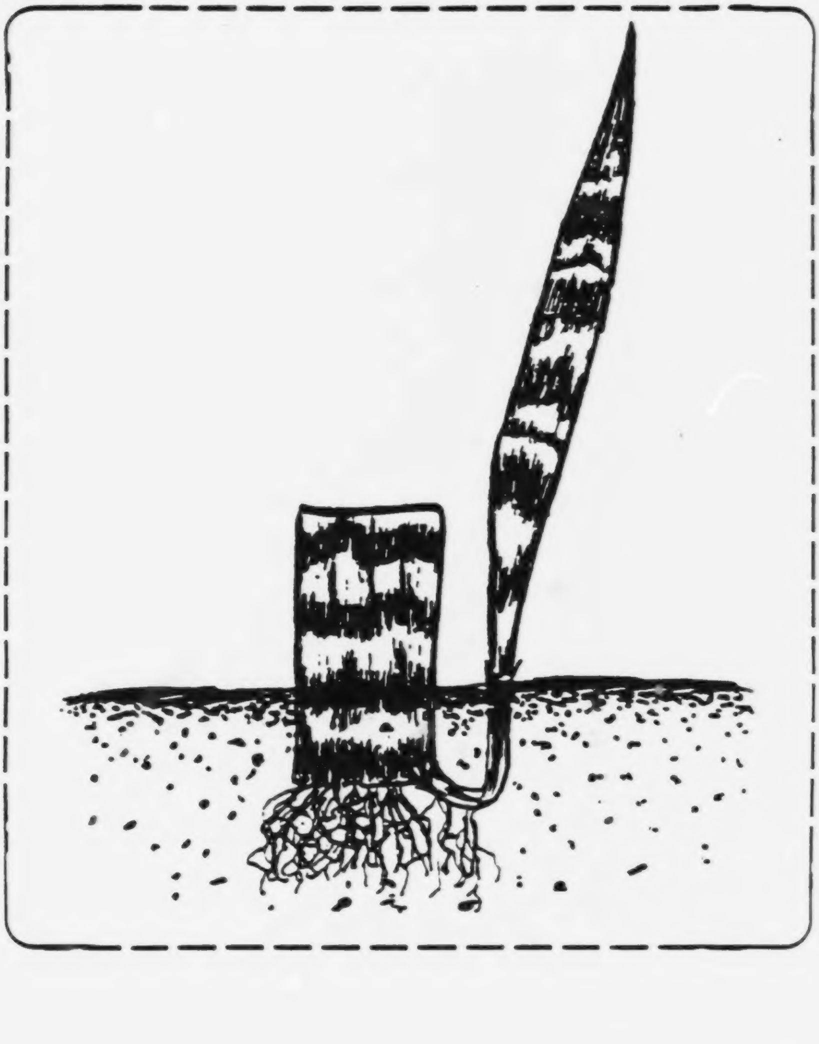
Insert Cuttings in Rooting Medium



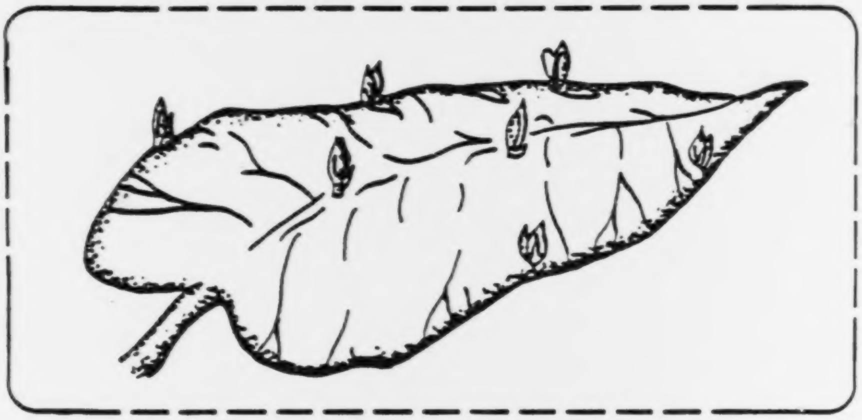
Measure Distance to Next Slit to Be Made with Knife



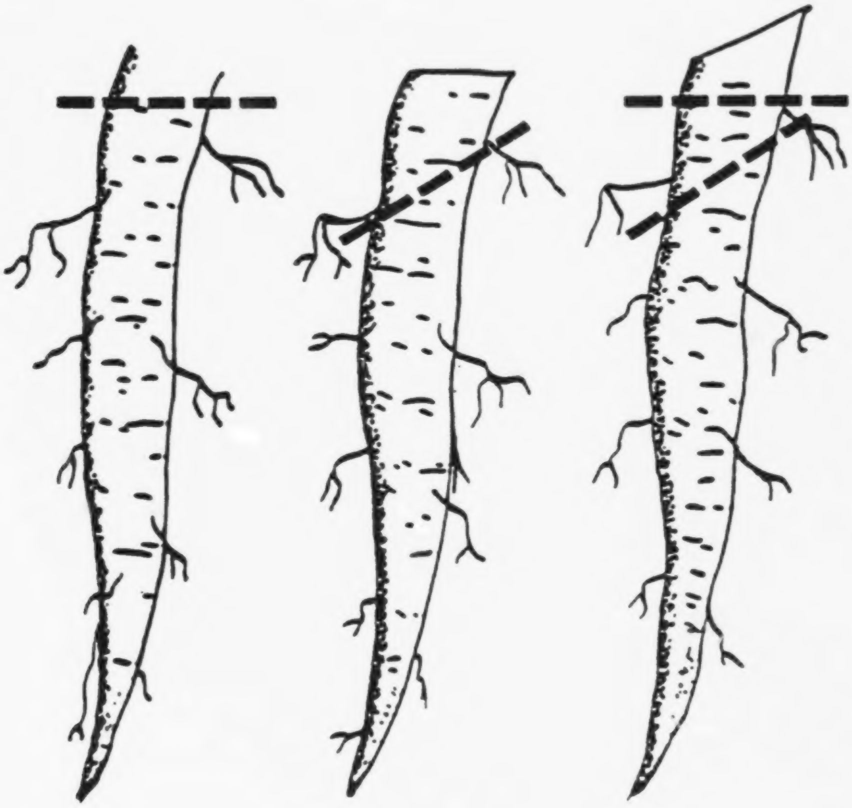
Leaf Cutting from *Sansevieria*



A New Plant from Each Cut Made on the Under-Surface of Leaf Veins



Obtaining Cuttings from Fleshy Roots

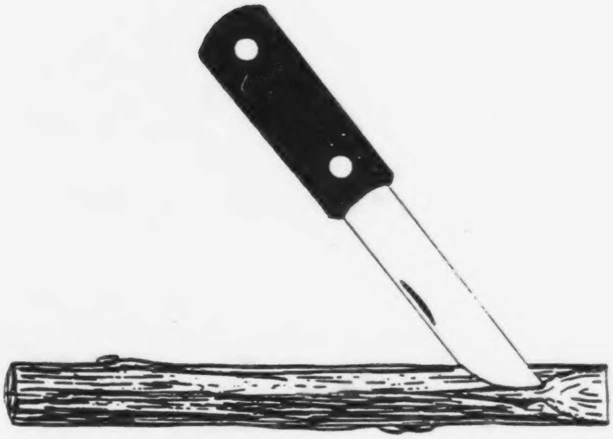


Step 1 Step 2 Step 3

Aids in Rooting Cuttings

1. Heat
2. Hormones
3. Wounding
4. Growing Medium
5. Humidity

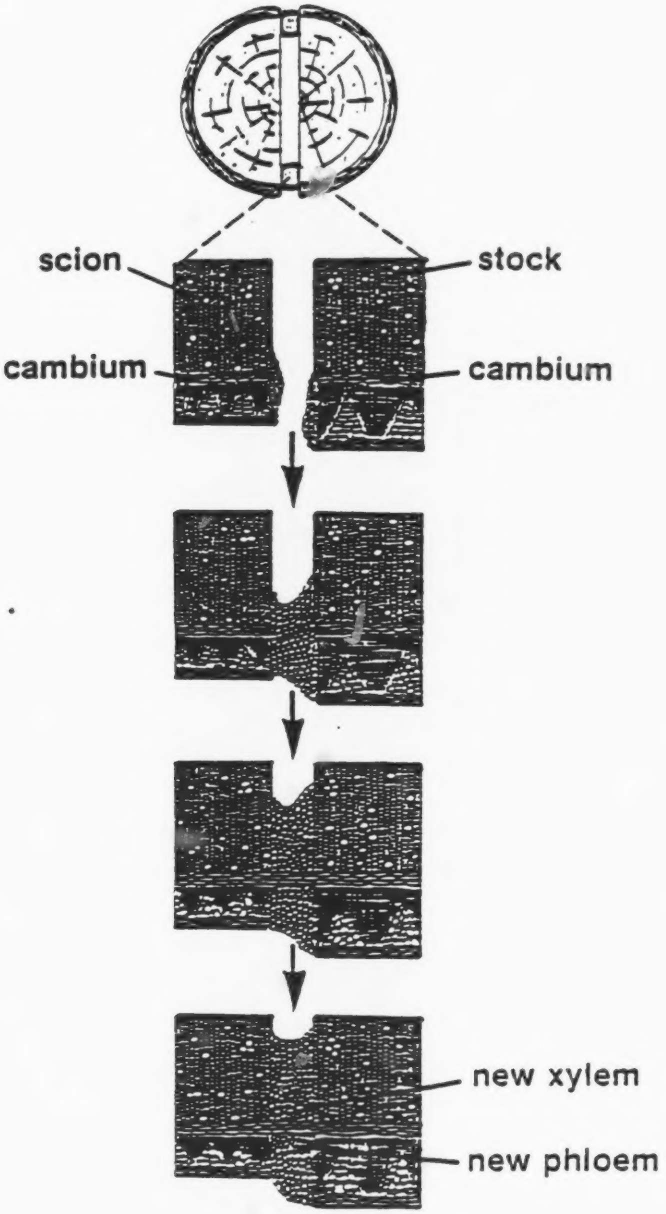
Wounding a Cutting



Types of Grafting

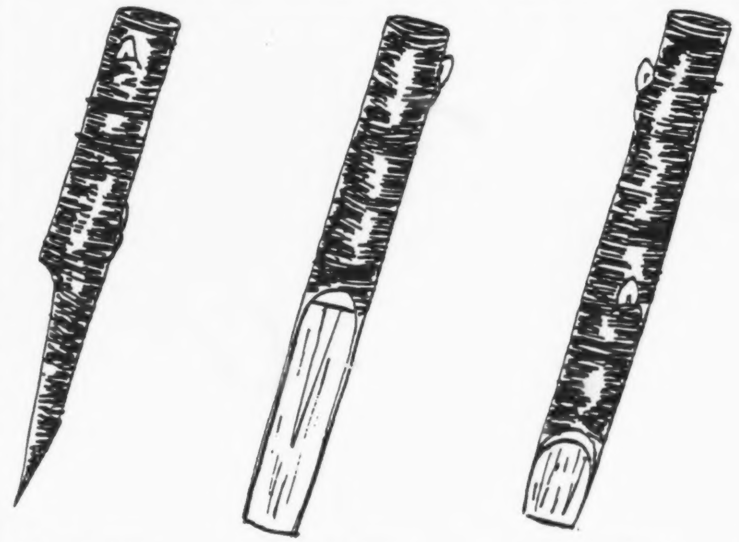
1. Cleft graft
2. Bench (Whip) graft
3. Side graft
4. Bark graft

Growth of Cambium Cells


scion
stock
cambium
cambium
new xylem
new phloem

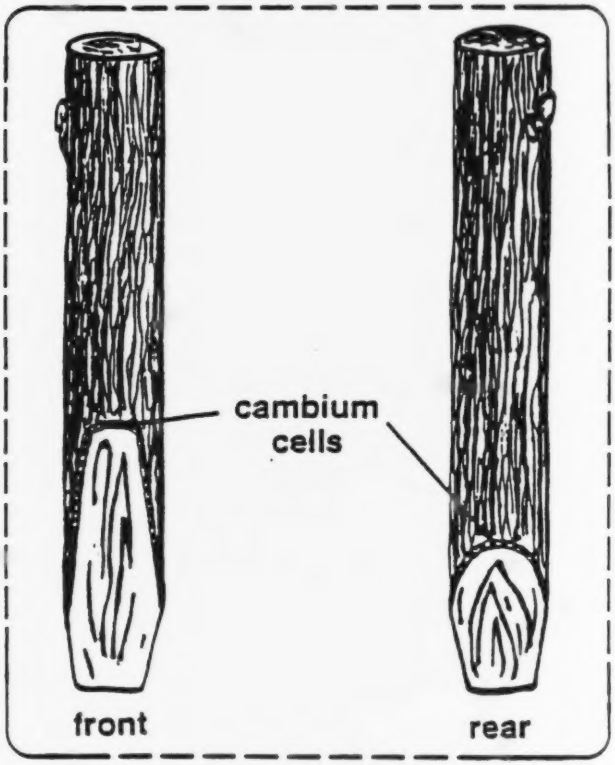
Some of these cells eventually become specialized xylem and phloem cells.

Different Views of a Scion Prepared for Bark Grafting

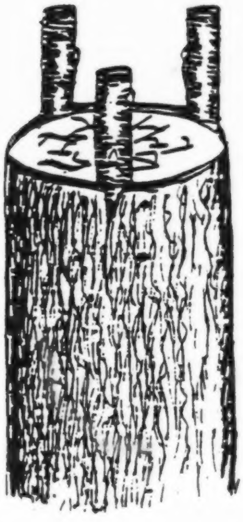


side view back view front view

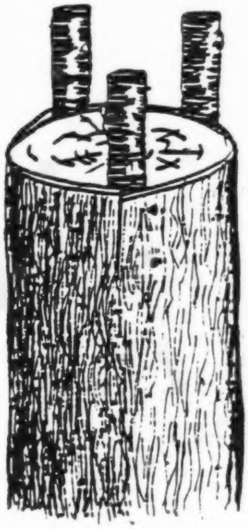
Exposure of Cambium Cells with Both Cuts on a Scion


cambium cells
front
rear

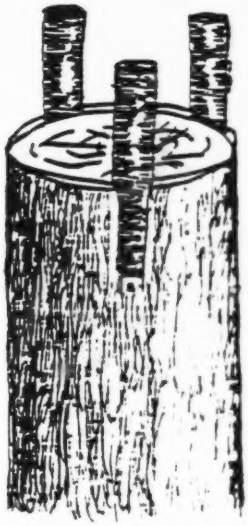
Three Methods of Inserting Scions into the Bark



METHOD #1

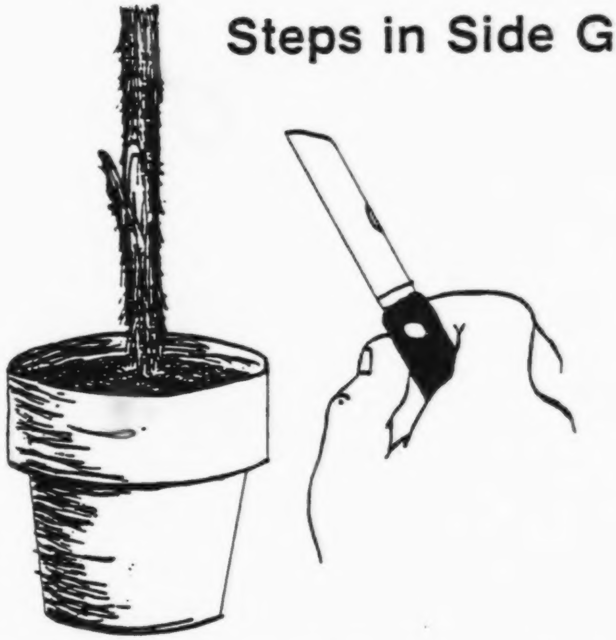


METHOD #2

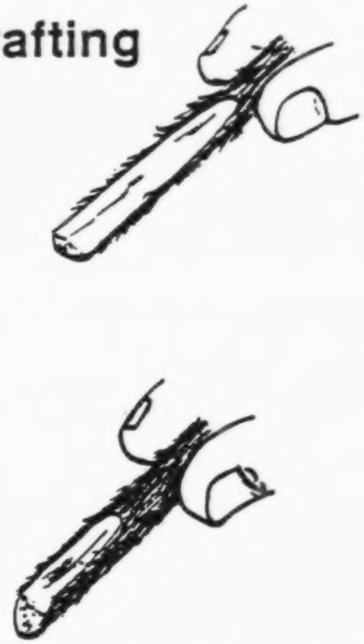


METHOD #3

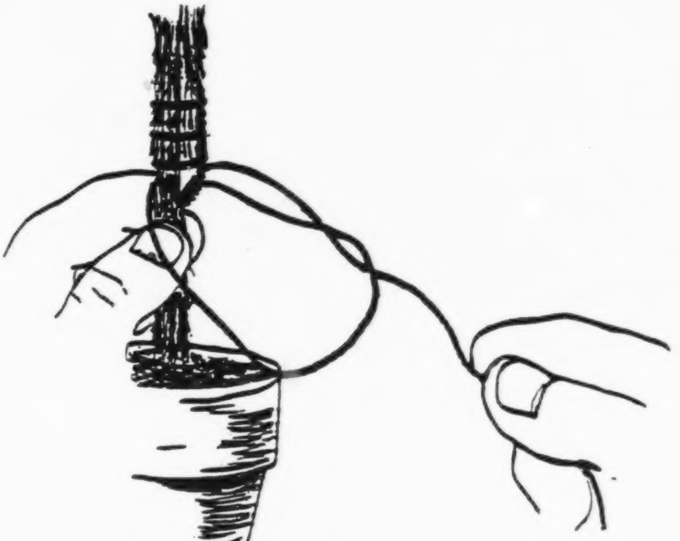
Steps in Side Grafting



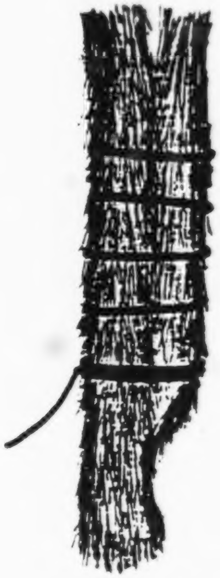
Small cut is made on understock.



Top and bottom views of cuts on scion.



Scion is placed on cut on understock and tied.

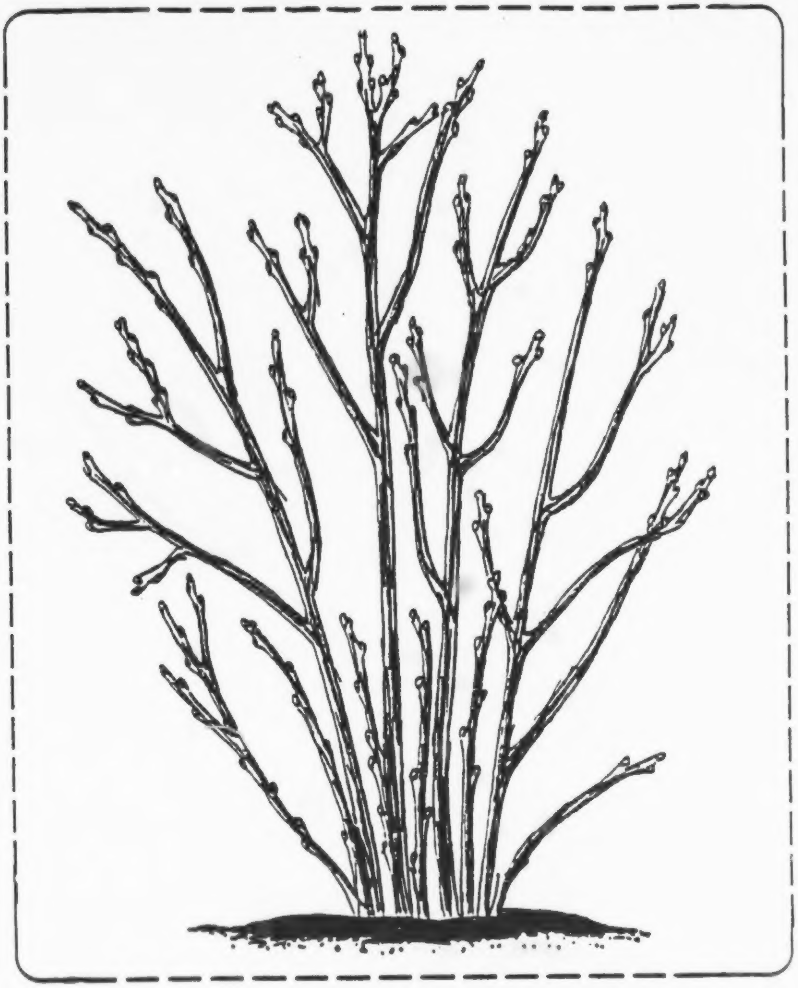


The completed graft

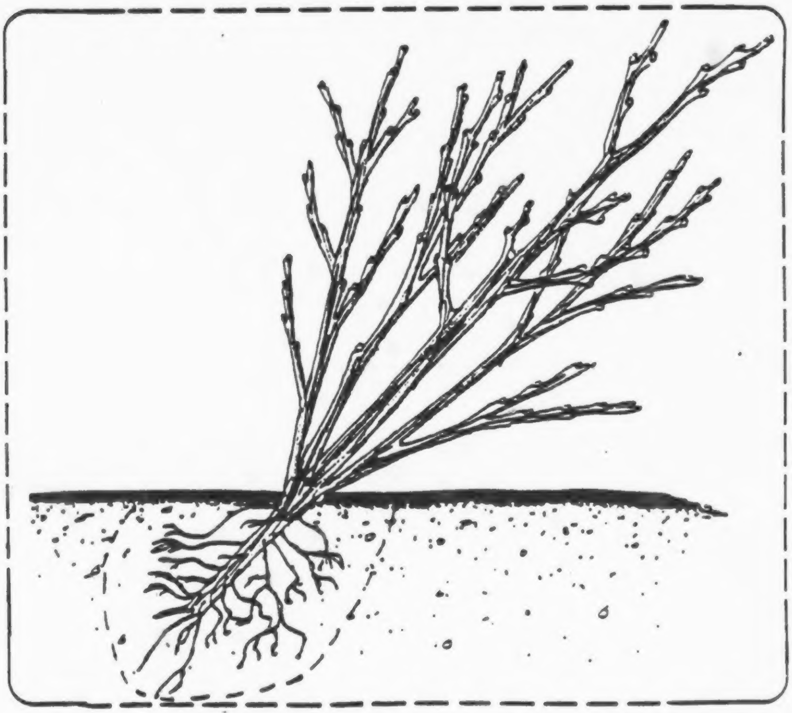
Types of Layering

1. Simple layering
2. Tip layering
3. Compound layering
4. Mound (Stool) layering
5. Trench layering
6. Air layering

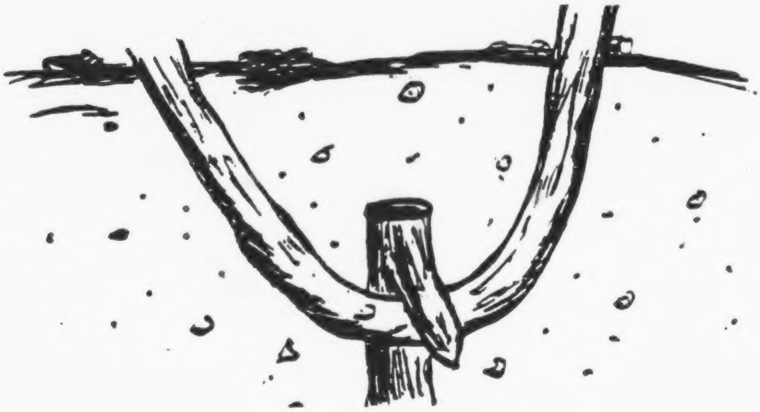
Well-branched Plant to be Used for Layering



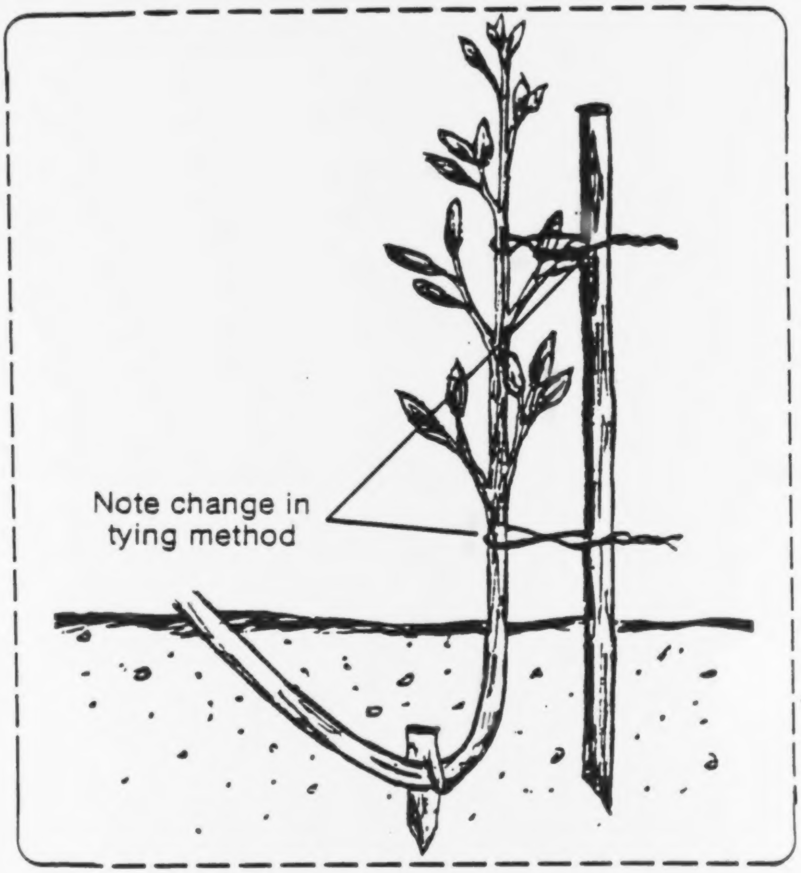
Heeled-in Mother Plant



Sharply Bent Stem That Has Been Pegged Down and Covered with Soil

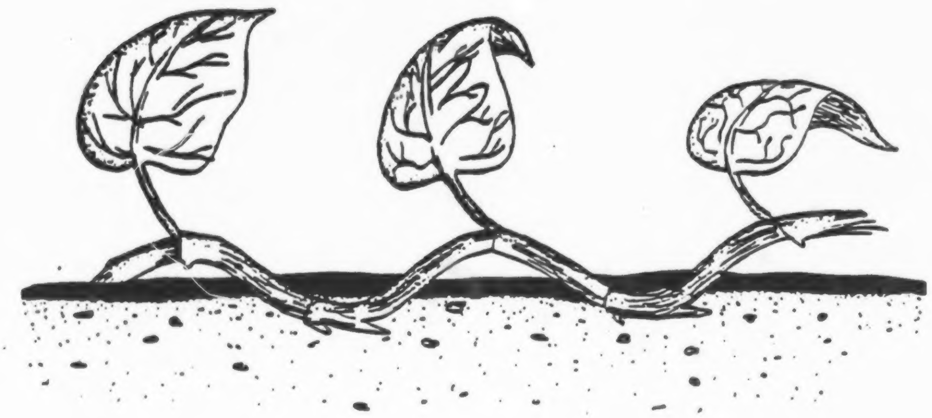


Layered Stem is Staked to Maintain an Upright Position

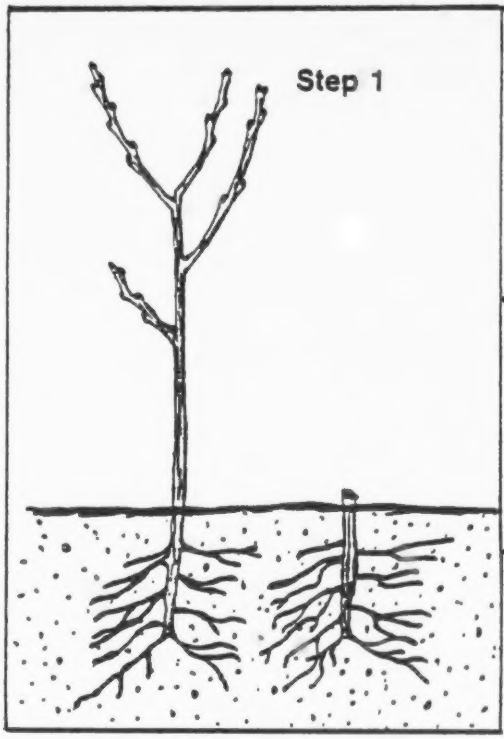

Note change in
tying method

264

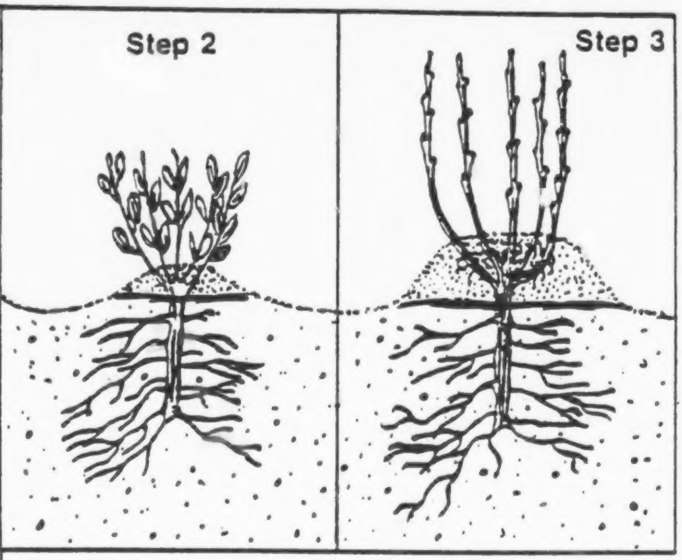
Compound Layering



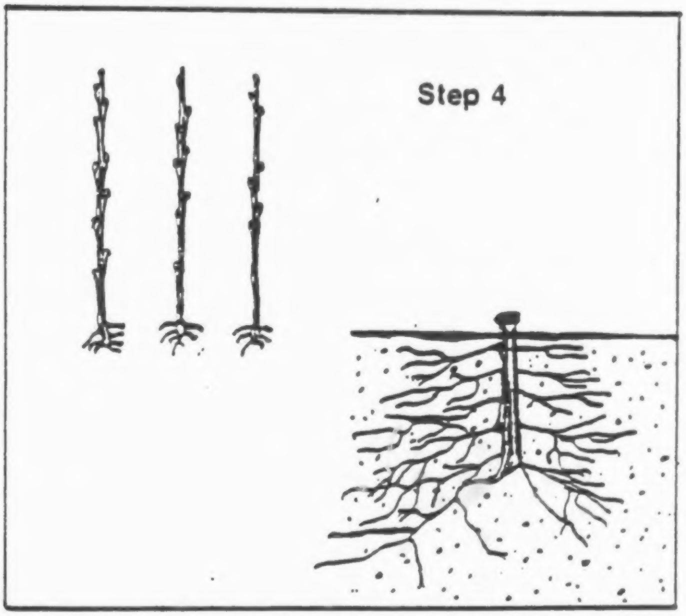
Steps in Mound (Stool) Layering



Cut parent plant to 1" above soil level.

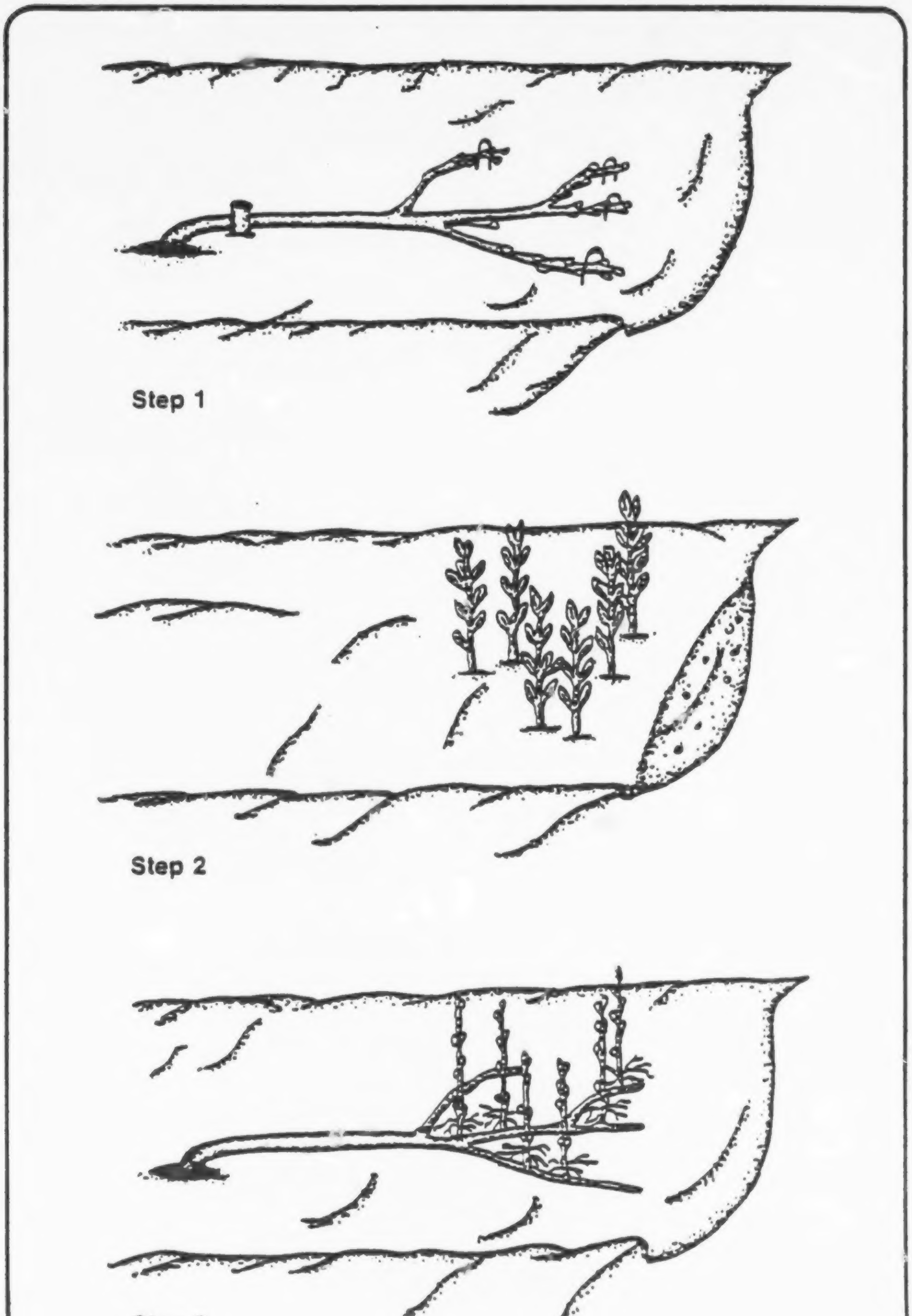

Step 2
Step 3

Mound up soil as shoots grow.

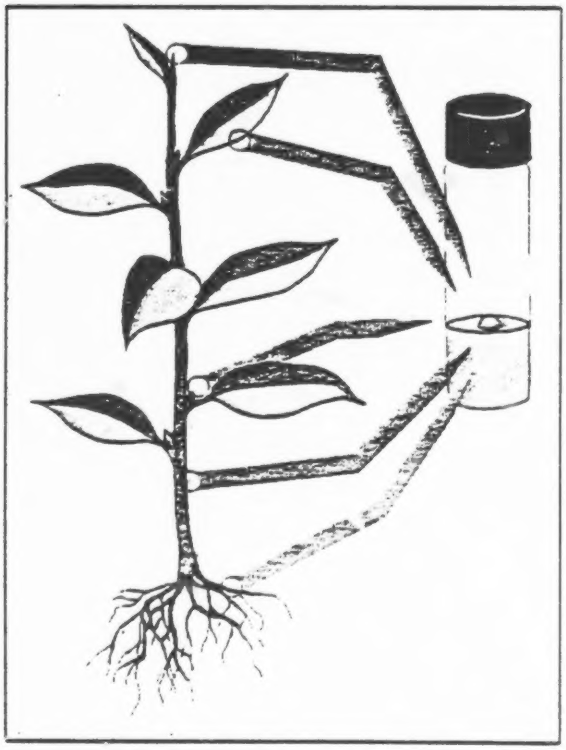


When grown, cut rooted shoots from parent plant and line out in nursery row.

Steps in Trench Layering

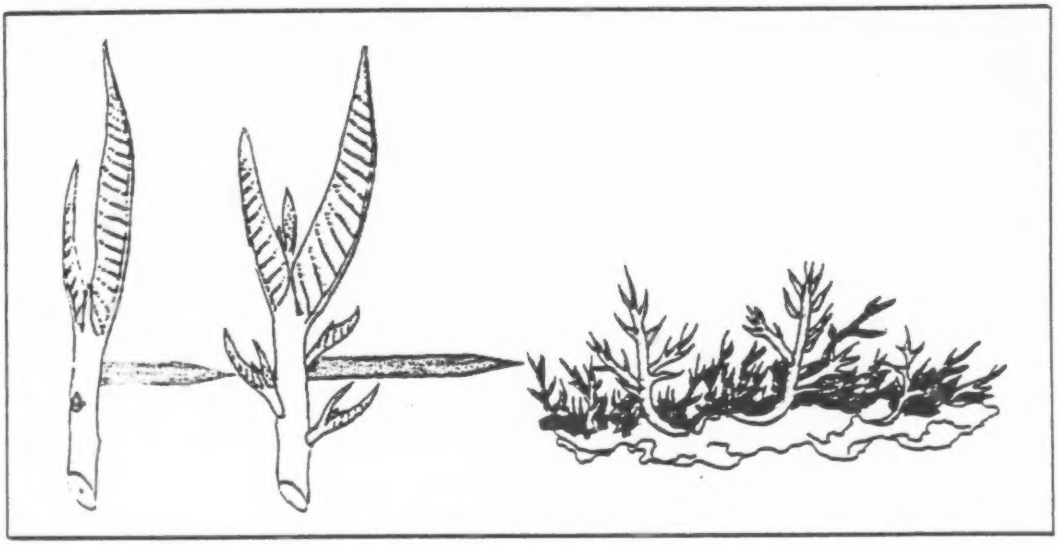

Step 1
Step 2
Step 3

Tissue Culture



Tissues from many different locations in the plant can be used for tissue culture. The plant part (explant) which gives most rapid shoot multiplication varies with the plant species.

Elongating Shoot Tips Used for Tissue Culture



CHAPTER 6

NURSERY FIELD PRACTICES

PERFORMANCE CHECK LIST

1. Demonstrate the process of transplanting annual seedlings.
2. Identify various types of containers available for growing and merchandising annuals.
3. Demonstrate how to transplant seedlings from flats to merchandising containers.
4. Demonstrate the process of transplanting liners for container-grown stock.
5. Demonstrate usage of equipment used for planting various-sized stock in the field.
6. Explain how to stake different-sized plants properly in the field.
7. Describe the condition of apical dominance in plants as it relates to pruning.
8. Demonstrate how to prune evergreens, shrubs, and trees.
9. Use growth regulators to simplify the pruning operation.
10. Explain the importance of watering newly planted stock.
11. List the types of irrigation equipment usually found around nurseries.
12. Distinguish between plastic tubing for individual cans and sprinkler irrigation for container-grown stock.
13. List the equipment used by nursery operators to harvest nursery stock and explain how each piece of equipment functions.
14. Demonstrate how to ball and burlap a nursery plant properly.
15. Identify various hand tools used around a nursery.
16. Demonstrate how to sharpen a budding or grafting knife properly.
17. Identify several ways to avoid accidents with tractors.

SUGGESTED LEARNING ACTIVITIES

1. Visit a Christmas tree farm and prune 25 evergreens.
2. Conduct a tool sharpening day. Have teachers and parents bring in various horticultural tools to be sharpened free of charge.
3. Visit a local nursery and have students ball and burlap shrubs and trees by hand.
4. Have students practice transplanting annual seedlings. Pay close attention to the number of flats they transplant per hour and the quality of the transplanting.
5. Have students distinguish among Jiffy-7's, Jiffy-9's, cell packs of different sizes, and peat pots.
6. Have students prepare soil and line out nursery stock either in the school nursery or at a local nursery.
7. If you do not already have one, develop a nursery at the school. Use cuttings or seedlings obtained with propagation practices studied. Develop a continual production program.
8. Visit a nursery and observe practices used, including staking, pruning, transplanting, lining out, etc.
9. Invite an irrigation expert to speak on watering practices and methods of conserving water in the system.
10. Attend a trade show and view various types of nursery machinery and equipment.
11. Purchase nursery liners and transplant them into the nursery field or into containers.
12. Contract to prune a homeowner's landscape plants.
13. Contract with a local nursery to dig and ball-and-burlap evergreens.
14. Prune various types of trees and shrubs in the school landscape or at home.

SAMPLE INTEREST APPROACH

Show students a series of plants varying in size from transplant stage to final size in large, final container. Point out that these are some of the stages of growth and development of the plant from propagation until it is ready for sale.

Have students tell when each change of container is needed. When students cannot explain this clearly, make the point that they need to know more.

Ask the class "Why not just plant the transplant into the final container to begin with?" Develop a discussion of why this is not done.

NAME ______________________

KEY QUESTIONS FOR CHAPTER 6

PART 1

Transplanting

1. How are annuals transplanted? (page 126)

2. When are annuals transplanted? (page 126)

3. What types of containers are used for growing annuals? (page 126)

4. How are liners transplanted into the field? Give 5 steps. (pages 127, 129)

   1) ______________________
   2) ______________________
   3) ______________________
   4) ______________________
   5) ______________________

5. What are the advantages of using *Jiffy-7's*? (page 126)

6. Why is it important to "harden off" annuals? (page 127)

Staking

7. Why are nursery plants staked? (page 130)

8. How are nursery plants staked? (pages 130-131)

NAME ______________________

PART 2

Pruning

1. What is apical dominance in plants? (page 132)
2. How are shade trees pruned? (page 134)
3. How are deciduous shrubs pruned? (pages 134-135)
4. How are narrowleaf evergreens pruned? (page 136)
5. How are broadleaf evergreens pruned? (page 136)
6. How are roses pruned? (pages 136-137)
7. What is an espalier? (page 138)

NAME ____________________

PART 3

Irrigation

1. What is irrigation? (page 140)

2. What is the most popular type of irrigation system used by nursery operators? (page 140)

3. What is the rule-of-thumb for watering established nursery field stock ? (page 141)

4. How does watering of container plants differ from watering of field stock? (pages 140-141)

Harvesting

5. How is bareroot stock harvested? (page 142)

6. What are the advantages of harvesting plants by the ball-and-burlap method? (page 143)

7. Which is better — the bareroot method or the ball-and-burlap method? Why? (pages 142-143)

NAME ______________________

PART 4

Tools and Equipment

1. Name some of the hand tools used in a nursery. (pages 146-149)

2. How does a shovel differ from a spade? (pages 148-149)

3. What are the most common uses of tractors in a nursery? (page 149)

4. Why is tractor safety important? (page 149)

5. List ten ways to avoid accidents with tractors. (pages 149-150)

1) ______________________
2) ______________________
3) ______________________
4) ______________________
5) ______________________
6) ______________________
7) ______________________
8) ______________________
9) ______________________
10) ______________________

NAME ____________________

TERMS TO REMEMBER - Chapter 6

PART 1

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 6 of *The Nursery Worker.*

Technical Vocabulary

- annual
- apical dominance
- espalier
- hone
- hybrid tea
- leggy
- liner
- oilstone
- seeding
- shovel
- spade
- transplant

____________________ 1. Tall and spindly. (glossary)

____________________ 2. Term used to describe the suppression of side shoot development when the apical (tip) bud on a stem is present. (page 132)

____________________ 3. A plant trained to grow decoratively along a railing or trellis. (page 138)

____________________ 4. To sharpen a knife. (page 147)

____________________ 5. A device used to sharpen a knife. (page 147)

____________________ 6. To shift plants from one container to another. (page 126)

____________________ 7. A hand tool consisting of a broad scoop, or a more or less hollowed out blade with a handle. Used to lift and throw material. (page 148)

____________________ 8. A digging tool adapted for being pushed into the ground with a foot. (page 148)

____________________ 9. Rose plants which produce large flowers singly. (glossary)

____________________ 10. Planting seeds. (glossary)

____________________ 11. A plant that completes its life cycle in one year. (page 132)

____________________ 12. A young plant placed in a field row. (page 127)

NAME ____________________

TERMS TO REMEMBER - Chapter 6

PART 2

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 6 of *The Nursery Worker.*

Technical Vocabulary

arborist
auxin
bedding plant
cane
grandiflora
hardening off
Jiffy-7
leader
limbing up
lining out
mechanization
perennial

____________________ 1. A pruning process by which lateral branches that have sprouted near the ground are removed. (page 133)

____________________ 2. A plant that continues to live from year to year. (glossary)

____________________ 3. A specialist in the care and maintenance of trees. (page 134)

____________________ 4. The process of placing young plants in rows in a field. (page 127)

____________________ 5. A chemical or growth hormone found in plants. (page 132)

____________________ 6. A herbaceous plant, generally annual, grown for outdoor garden use. (page 126)

____________________ 7. A rose stem. (page 136)

____________________ 8. The primary or terminal shoot of a plant. (page 134)

____________________ 9. The process of acclimating plants to outdoor conditions. (page 127)

____________________ 10. A rose plant which produces large flowers in clusters on the rose stems. (page 137)

____________________ 11. A compressed peat pellet which combines the functions of a pot and potting soil in one unit. (page 126)

____________________ 12. The process of replacing human labor with equipment. (page 130)

NAME ______________________

LETTER MAZE 6

The 20 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

E Q J V C N U M X R X Q X I O M E C H A N I Z A T I O N X R
F L H J Z Q M G Y V G S N F R U K H V C X F X N Q K A L E I
G O F M F S E B W R K Z R T X U L L J G E M Q U Y P O I I P
S N P W J U I B G M M F V V D A X C Y U Y K O G K G L D U M
E S H O V E L M M J S I H U I T B E F O E A J S L A X K Q U
P Y F T L L E G G Y J H H N T M C F U Y H R I H P C N B E I
A P A C S T Z G X R P I N P U L F P P Q Z Z T S O S A K T K
A N N U A L G F U I T E H W I H T A Q I M N E S Y N G P Q C
K B S R P W T U U O R L D R C U I H E Z A I I A Y N E V M D
P V C T E D F Q Z E R G I K Q Q B M D L Y I U S I O Z T W W
Y Q Z H X W M Q P B O Y V B A W C C P Y T N K D T I T E J T
V U F Y Y Z D Z I H Y I M M W U P S F F S C E O O J A K V A
R P I E F N U S X T Q B H E B V N B F M G E B F J X V I K X
Q J W S V D O W E V M R G P A A A E U A S B X Q G W C A A G
S V W P G K X B K M E S D D R F N D W D N N V M R G Z X X S
J C J P D D N X X D V X I T J A D D T W I E L T F M E D J X
T L F O W O F B A F V E K M C K D T P X G L J B L C W C J I
I L E B H W G E W P N X A G K U M J U E G I I G N V F N Z E
B T X X C L L M D E H R U H A N W A N E F P X N R W L W G P
W T W S L G H Z K P O R X Y X T R J H G Y K X P E O T R E M
J V M K H B Q B T L T B S U A Y B Y P A Z N W T C R H G D M
H J C J W Z G Z F S O Q E F T I A L F C V H N T C I N B S H
Q O F Z C Y Y I I S H L O D V R E O R T U F I W B F L Q K D
V K A J O R D R I Z B S P A D E S A A A A E B A L B R G I Y
K A H V S N O L T O E H I G M I V Z F H U Z W Z T P S H M U
G S R A A B L R S N N A E F X L N I T Q B S L M Z X S K X T
Q V A R R E S I O Y Y D Q S A N W G O D H A U K K M G X Y S
L L G A R N M T Q D Z N Z S C M P Z P B M L V L X D O L H S
I Z B T Q A S T Y V M T R O A E N D T L Q L Y S D B W T X W
E I W M Q L L B J J Y M M G F J A V P B A W U Z A S I A W E
N Y M F I V J S O N V L S T P W Y I O L H N L N I X U N H H
N S M O A P M M G P K K T Y R H P C V T F V T J M O S U J W

ANNUAL
APEX
ARBORIST
AUXIN
BEDDING PLANT
CANE
ESPALIER
GRANDIFLORA
HONE
LEADER
LEGGY
LINER
MECHANIZATION
OILSTONE
PERENNIAL
SEEDING
SHOVEL
SPADE
TRANSPLANT
TRELLIS

Crossword Puzzle 6- Clues

ACROSS Clues

5. A plant that continues to live from year to year. (glossary)
8. A material in which the roots of newly dug trees are sometimes wrapped. (page 143)
9. A young plant grown in a field row. (page 127)
10. A plant growth hormone. (page 132)
13. A ________ tea rose is generally pruned before spring growth begins. (page 137)
15. A specialist in the care and maintenance of trees. (page 134)
16. To move a plant from one container or location to another. (page 125)
18. A scooplike tool or implement used for lifting and throwing materials such as soil. (pages 148-149)
19. The woody stem of a rose plant. (pages 136-137)
20. A plant which completes its life cycle in one year. (page 132)
22. A method of training plants to grow in a special form. (page 138)
23. A type of rose which bears many flowers on each stem. (page 137)
24. A device used to sharpen knives. (page 147)

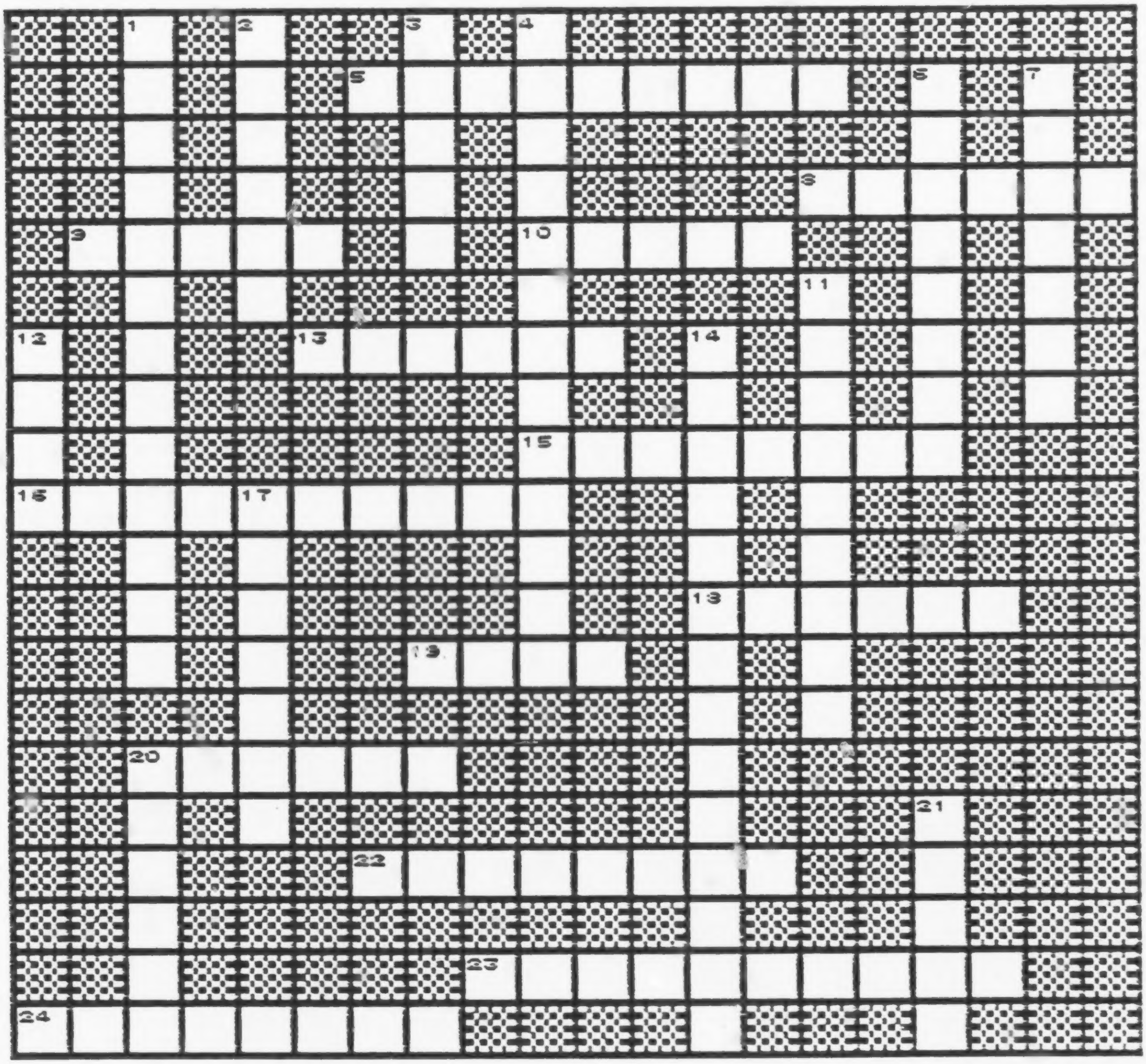
DOWN Clues

1. Another term for annual plants in the garden (2 words). (page 126)
2. The central stem or branch of a plant. (glossary)
3. Tall and spindly. (glossary)
4. The process of using machinery to replace personnel whenever possible. (page 130)
6. A plant from which all growing medium or soil has been removed. (page 142)
7. A piece of power equipment often used in nurseries. (page 149)
11. Plants which lose their leaves at the end of the growing season. (glossary)
12. A tray for carrying plants. (pages 125-126)
14. The food-manufacturing process of plants. (page 133)
17. Planting seeds. (glossary)
20. When the tip bud from a stem is removed, the side buds will begin to grow. Removing the tip bud also removes ________ dominance. (page 132)
21. A sharp digging tool that can be used to cut feeder roots. (pages 148-149)

NAME ______________________

CROSSWORD PUZZLE 6

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker*.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

NAME ______________________

STUDENT EXERCISE 6-A

TRANSPLANTING BEDDING PLANTS

Seedlings are very fragile. You must be careful when transplanting them. Carelessness and rough handling will result in a large number of dead plants. In this exercise you will learn how to transplant bedding plants successfully.

MATERIALS:

- seedlings
- labels
- dibble
- watering devices
- waterproof markers
- sterilized potting soil
- empty flats and packs

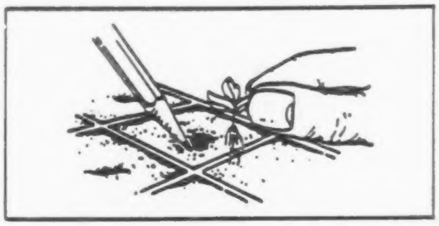


Figure 6-1. Making a hole for the seedling.

PROCEDURE:

1. Ask your instructor what plants are to be used in this exercise and how many flats are to be transplanted.
2. Locate the area in which you are to work.
3. Move the containers, labels, and flats to the potting area. Be sure there is enough moistened, sterilized potting soil to complete the job.
4. Assemble the flats and packs you will need.
5. Take the assembled flats and packs to the potting bench and fill the packs with potting soil.
6. Take the filled flats to the transplanting area.
7. Determine the type of plant and variety name of the seedlings you will be transplanting.
8. Label each flat with the following information: (1) type of bedding plant, (2) variety, and (3) transplanting date.
9. Gently remove the seedlings from the propagation flat. Do not remove more seedlings than you can grade and transplant in 15 minutes. If root systems dry out, the plants will die.
10. Before transplanting, it is important to grade the seedlings for uniformity. If one or two of the seedlings in a pack are half as tall as the others, the finished product will also be uneven and less attractive.
11. Using an empty flat, transfer the graded seedlings to the transplanting area. Place the seedlings in front of you at the front edge of the table.
12. Place the filled flat in front of you.
13. Pick up the dibble and with the sharp end make an inch-deep hole in the middle of each cell of the filled flat (Figure 6-1).
14. Holding a seedling gently in your hand, and with the aid of a dibble, put a seedling in each cell (Figure 6-2). Be careful that the seedling is not planted too deep. Also make sure that all the roots are buried.
15. Continue until all the cells of the flat are filled.
16. Place the transplanted flat in the greenhouse and water it immediately (Figure 6-3). Be careful not to wash the seedlings out of the packs.

(continued)

Student Exercise 6-A (continued)

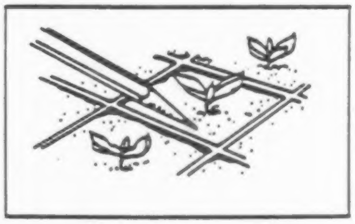


Figure 6-2. A seedling in the center of each cell.

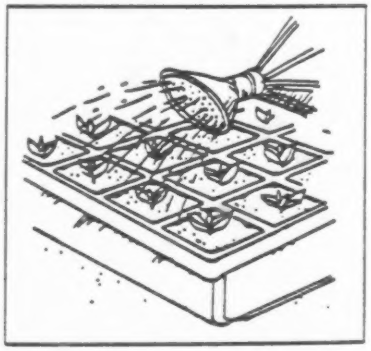


Figure 6-3. Watering the transplanted seedlings.

EVALUATION:

1. Seedlings were handled carefully. ______________
2. Seedlings were correctly graded. ______________
3. Seedlings were planted at the proper depth. ______________
4. All flats were correctly labeled. ______________
5. All flats were watered and placed at the correct bench location. ______________
6. The assigned number of flats was completed. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-B

TRANSPLANTING CUTTINGS

Transferring rooted cuttings to pots and other containers is the final step in any propagation program. In this exercise you will select plants that have formed roots and transfer those cuttings to containers.

MATERIALS:

- rooted cuttings
- empty flats
- pots or other containers
- potting soil
- watering devices
- labels

PROCEDURE:

Note: Many plants have very fragile root systems. You must handle cuttings gently at all times.

1. Determine the date the cuttings were made. Most herbaceous cuttings take 14 to 21 days to root.
2. Gently pull on the top of the cutting. If it seems to "tug back," it is rooted. Use the test on several cuttings in the flat. If over half "tug back," the flat is ready to transplant.
3. Carry the flats to the potting area. Your instructor will tell you what type of pots to use.
4. The potting area should be set up for efficiency. Place the flat of rooted cuttings to the right of the soil pile. The pots should be placed slightly to the left and on top of the soil pile with several empty flats to your left (Figure 6-4).
5. Remove each cutting from the propagation flat by carefully sliding a flat tool under the cutting while gently holding and lifting the top of the cutting with your fingers.
6. **Do not remove** more cuttings than you can pot in fifteen minutes. If roots dry out, the plants are dead!
7. Pick up a container with your left hand and scoop in soil to fill the container approximately one-third full.
8. Pick up a cutting with your right hand and insert it in the pot (Figure 6-5).
9. With your left hand fill the container to the top.
10. With the thumb and forefinger of each hand, gently firm the soil in the container around the base of the cutting (Figure 6-6).
11. Transfer the potted cuttings to an empty flat at your left. When the flat is full, transfer it to the greenhouse and water it.

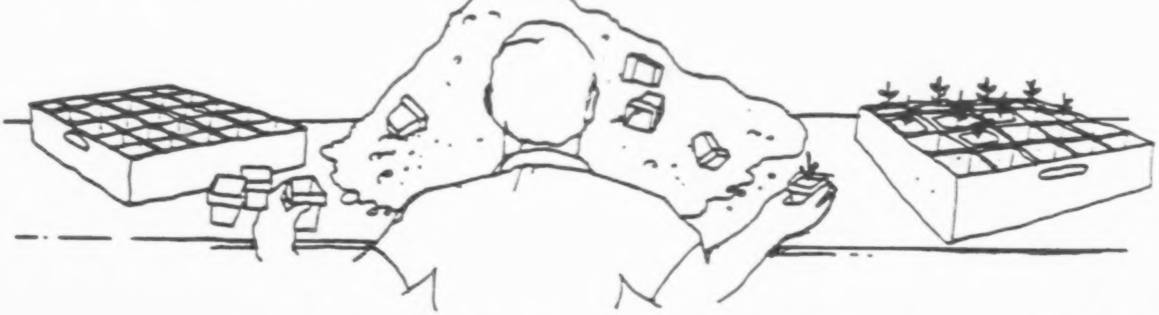


Figure 6-4. Potting area set up for efficiency.

(continued)

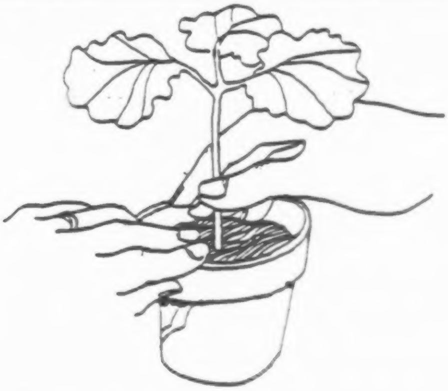


Figure 6-5. Inserting a cutting into a pot.

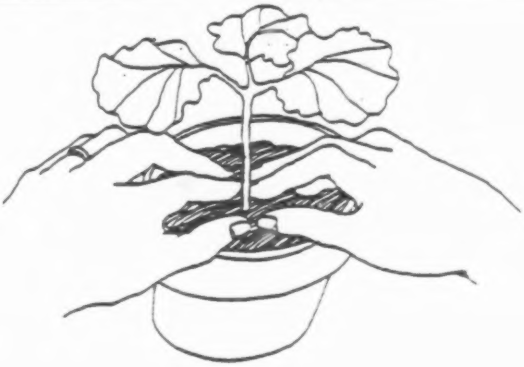


Figure 6-6. Firming the soil around the cutting.

EVALUATION:

The student:

1. Determined which cuttings were well rooted. ____________
2. Set up the potting area for efficiency and speed. ____________
3. Removed cuttings from the propagation flat with no root damage. ____________
4. Used an acceptable technique in potting the cuttings. ____________
5. Watered the potted cuttings within 15 minutes of potting. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-C

PRUNING TERMINOLOGY

Pruning is the removal of certain plant parts to improve the plant in some way. Most landscape ornamentals need pruning to improve their appearance and to maintain their health and vigor. To prune correctly, you should understand the pruning terms used in references and by nursery workers. You should also be able to identify the various parts of the plant which are normally pruned.

MATERIALS:

- sharp #2 pencil with eraser
- several pieces of notebook paper
- pruning references

PROCEDURE:

Define the following terms **as they relate to pruning.**

1. bleeding ____________________
2. broadleaf evergreen ____________________
3. candle ____________________
4. central leader ____________________
5. crotch ____________________
6. deciduous ____________________
7. dormant ____________________
8. drop crotching ____________________
9. heading back ____________________
10. lateral ____________________
11. narrowleaf evergreen ____________________

(continued)

Student Exercise 6-C *(continued)*

12. pluck pruning ______________________________

13. shearing ______________________________

14. sucker ______________________________

15. terminal ______________________________

16. thinning ______________________________

17. wound ______________________________

18. wound dressing ______________________________

EVALUATION:

All pruning terms were adequately defined. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-D

PRUNING YOUNG DECIDUOUS TREES

Early pruning to direct the growth of young trees is very important. However, there should be only enough pruning done to direct the tree's growth and correct structural weaknesses. For greatest strength, branches selected as permanent branches must have wide angles of attachment with the trunk (Figure 6-7). In this exercise you will prune trees according to the procedure outlined below.

MATERIALS:

- hand pruning shears
- leather gloves
- lopping shears

Safety notes on hand pruning shears:

1. Keep shears latched or closed when they are not in use.
2. Keep free hand away from cutting edges when shears are in use.
3. Do not overstress shears by trying to cut materials too large for the tool.
4. Do not cut wire or other materials with the shears.

PROCEDURE:

1. Select and assemble the tools and materials needed to do the job.
2. Determine the natural form of the tree at maturity (Figure 6-7).
3. Remove any branches that have narrow angles of attachment (Figure 6-8).
4. Remove any broken, damaged, dead, diseased, or insect-infested branches.

   Note: When pruning diseased plants, disinfect all shears and saw blades after each cut to prevent spreading disease to healthy plants. Alcohol or a chlorine bleach can be used to disinfect pruning tools.

5. Remove any branches that are too close together (Figure 6-9). Branches should be at least 8 inches apart (Figure 6-10). (20-24 inches apart is ideal.)

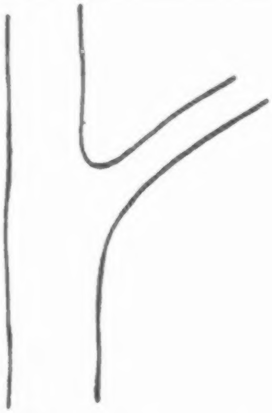


Figure 6-7. A branch with a wide, strong angle of attachment and plenty of room to grow.

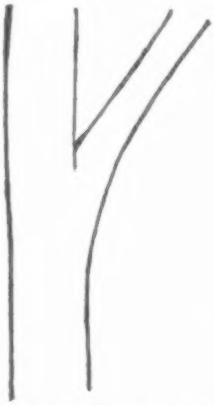


Figure 6-8. A branch with a narrow, weak angle of attachment. It may split off as the tree gets larger.

(continued)

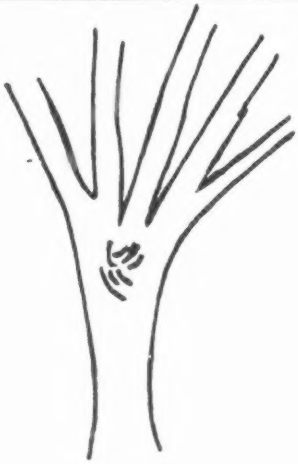


Figure 6-9. Branches clustered together produce a weak spot that may break apart during a storm.

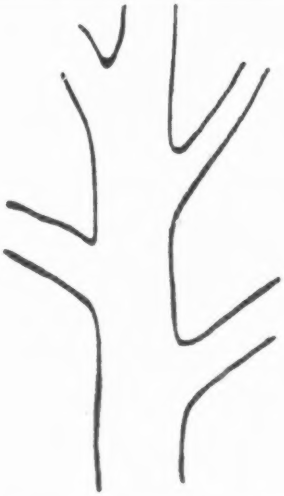


Figure 6-10. Permanent branches should be spaced at least 8" apart, the closer ones pruned.

6. Prune branches so they are not one above the other. Radial branch distribution should allow 5 to 7 permanent branches to fill the circle of space around the tree.
7. Prune laterals that are too close or vigorous; this keeps them from competing with the leader or terminal growth.
8. Prune back long branches to a side bud or side branch to shape the tree.
9. Remove clippings. Clean and store tools.

EVALUATION:

1. The correct tools for the pruning job were selected. ____________
2. The natural shape of the plant was maintained. ____________
3. All broken, damaged, dead, diseased, or insect-infested growth was removed. ____________
4. Branches with narrow angles of attachment were removed. ____________
5. Branches were removed so that good radial branch distribution resulted. ____________
6. Long lateral branches were pruned back to side bud or branch. ____________
7. Work area was cleaned up and tools were stored properly. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-E

PRUNING LARGE LIMBS

Limbs that are dead, weak, diseased, or insect-infested beyond repair should be removed. It is important to follow the proper procedure when removing large limbs. If the tree is injured or a stub is left, the resulting wound heals slowly (if ever). Disease organisms may enter the weakened tree, possibly leading to its death. In this exercise you will remove a large limb from a tree, making the proper cuts as outlined in the procedure below.

MATERIALS:

- hand pruning saw
- power chain saw

Safety notes for using a power chain saw:

1. Wear safety clothes (gloves, goggles, and helmet). DO NOT wear loose clothing.
2. Inspect chain and make sure equipment is in top condition before starting.
3. Before starting, be sure feet and legs are clear of the cutting chain.
4. Keep BOTH HANDS on the saw at all times to maintain proper control of the saw when it is running. DO NOT carry the saw when it is running.
5. Do not fill the fuel tank of the saw on turf or around the cutting area.
6. Keep the saw free of sawdust and flammable materials.

Safety notes for using a hand pruning saw:

1. Always carry and store the saw in a scabbard.
2. Do not force the saw. It will cause buckling.
3. Keep hands free of the blade.
4. Store the saw in a clean, dry place.

PROCEDURE:

Note: Removal of large limbs introduces safety hazards which were not present in other pruning jobs. Therefore DO NOT proceed with this exercise until you are told to do so by your instructor.

1. Select and assemble the necessary tools and equipment.
2. First, measure angles above and below the limb to determine the correct angle for the final cut (Figure 6-11).
3. Make the first cut on the underside of the limb. This will prevent stripping of the bark. Make this cut about 1½ inches to 2 inches deep.
4. Make the second cut on top of the limb 1 inch or 2 inches further out on the limb from the first cut (Figure 6-11). Cut until the limb is removed.
5. Now make the final cut to remove the stub (Figure 6-12). Be sure not to cut off the callus collar.
6. Clean up all debris from the site.
7. Clean and store all equipment.

(continued)

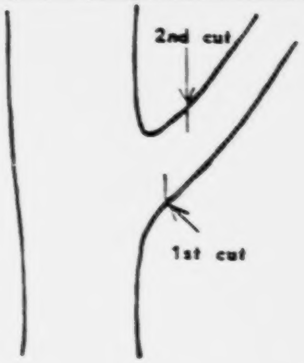


Figure 6-11. Positions of first and second cuts made to remove a large limb.

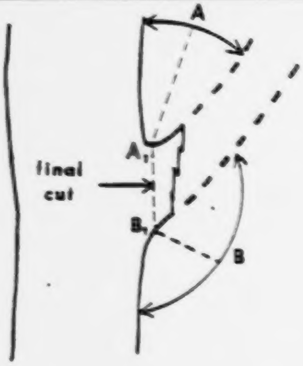


Figure 6-12. To determine correct angle of final cut, bisect angle A and angle B. Then cut from point A_1 to point B_1.

EVALUATION:

1. Correct tools for completing the job were selected. ______
2. The first cut was properly made on the underside of the limb. ______
3. The second cut was made in the proper location so that bark stripping was not a problem. ______
4. The stub was cleanly and neatly removed. ______
5. All debris was removed from the work site. All tools and equipment were cleaned and stored. ______

FINAL GRADE ______

NAME ____________________

STUDENT EXERCISE 6-F

PRUNING DECIDUOUS SHRUBS

Deciduous shrubs often need pruning to improve their appearance. Pruning promotes compact growth, develops natural form, and removes dead, diseased, and insect-infested wood. For plants that bloom in mid-summer, pruning is done before growth starts in early spring. Spring flowering shrubs are pruned right after flowering. Most deciduous shrubs need some maintenance pruning each year. In this exercise you will demonstrate your ability to prune deciduous shrubs properly.

MATERIALS:

- pruning shears
- leather gloves
- knife
- leaf rake

Safety notes on hand pruning shears:

1. Keep shears latched or closed when not in use.
2. When in use, keep free hand away from cutting edges.
3. Do not overstress shears by trying to cut material that is too large.
4. Do not cut wire or other materials.

PROCEDURE:

1. Assemble the necessary tools and materials.
2. Identify the natural shape of the plant (Figure 6-13).

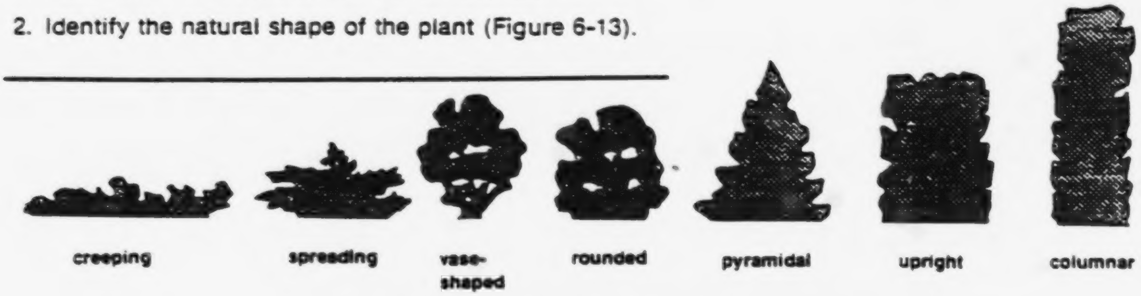


Figure 6-13. Growth habits of deciduous shrubs.

3. Cut any dead plant parts back to a healthy bud or side branch when using hand pruning shears.
4. When two branches rub together, remove the less desirable branch.
5. Remove any broken, diseased, or insect-infested growth.
6. Cut back any extra long growth that distracts from the natural plant form.
7. If there are isolated, new, strong shoots from the base, cut off the tip of these 18 to 24 inches from the ground to encourage branching. This will help keep the plant's natural shape.
8. Remove clippings from the job site.
9. Clean and store tools.

(continued)

Student Exercise 6-F *(continued)*

EVALUATION:

1. The shrub was pruned to its natural shape. ______________
2. All undesirable branches (crossed, broken, diseased, or insect-infested) were removed. ______________
3. The plant was properly shaped and thinned. ______________
4. All debris was cleaned up. Tools and materials were properly cleaned and stored. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-G

PRUNING NARROW - LEAF EVERGREENS

There are two types of narrow-leaf evergreens - **spreading** and **upright**. In this exercise you will learn to prune both types.

MATERIALS:

- hand pruning shears
- leather gloves
- knife
- leaf rake

Safety notes on hand pruning shears:

1. Keep shears latched or closed when not in use.
2. When in use, keep free hand away from cutting edges.
3. Do not overstress shears by trying to cut material that is too large.
4. Do not cut wire or other materials.

PROCEDURE:

1. Select and assemble the necessary tools and materials.
2. Identify the natural shape of the plant.
3. Cut any dead plant parts back to a healthy bud or side branch using hand pruning shears.
4. Remove any broken, diseased, or insect-infested growth.
5. Cut back any long growth that distracts from the natural plant form (Figures 6-14 and 6-15).

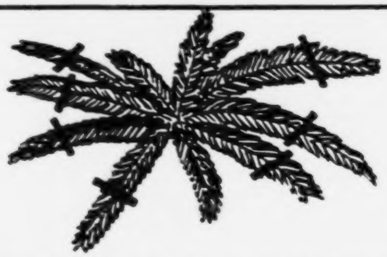


Figure 6-14. Pruning of long upper branches of spreading evergreens.

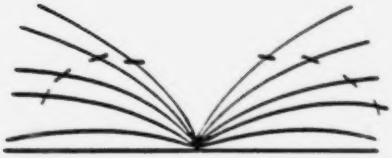


Figure 6-15. Lateral view of proper pruning so the lower branches are not shaded.

6. Thin out and shape the plant by cutting back ¼ to ½ of the new growth (Figure 6-16). Use hand pruners or a knife.
7. Remove multiple leaders on spruce and pine. Leave the best leader to develop into a new single leader (Figure 6-17).
8. On a central leader that is too long, cut back to a lower bud. This bud will then become a new leader.
9. Remove clippings from job site.
10. Clean and store equipment.

(continued)

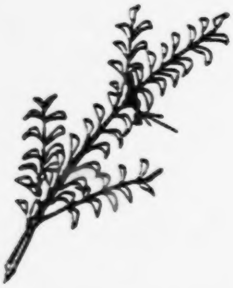


Figure 6-16. Pruning of yew branches.

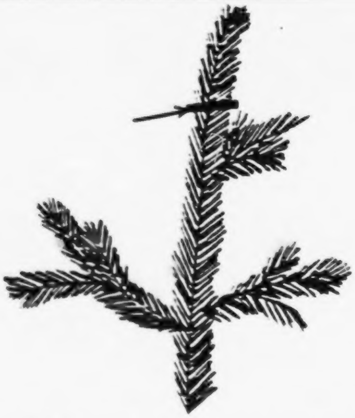


Figure 6-17. Pruning of spruce or pine leader.

EVALUATION:

1. The shrub was pruned to its natural shape. ______________
2. All undesirable branches (crossed, broken, diseased, or insect-infested) were removed. ______________
3. The plant was properly shaped and thinned. ______________
4. All debris was cleaned up. Tools and materials were properly cleaned and stored. ______________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 6-H

PRUNING BROADLEAF EVERGREENS

Broadleaf evergreens such as rhododendron, holly and boxwood need little if any pruning. The most important practice is the removal of spent flowers. Such removal results in greater growth of the plant and production of more flower buds for the next year. However, plants which produce fruit following flowering should not be pruned. The fruit should first be allowed to develop. In this exercise you will demonstrate your ability to prune these evergreens properly.

MATERIALS:

- hand pruning shears
- knife

PROCEDURE:

1. Select and assemble the necessary tools and materials.
2. Identify the natural growth habit of the plant.
3. Cut any dead plant parts back to a bud or side branch using the hand shears.
4. Remove any broken, diseased, or insect-infested growth.
5. Double check the plant variety to make sure that removing spent flowers will not destroy fruit production.
6. If appropriate, remove spent flowers. Snap them off with your fingers or cut them off (Figure 6-18).
7. Carefully shape the plant if necessary.
8. Remove clippings and debris from the work site.
9. Clean and store equipment.

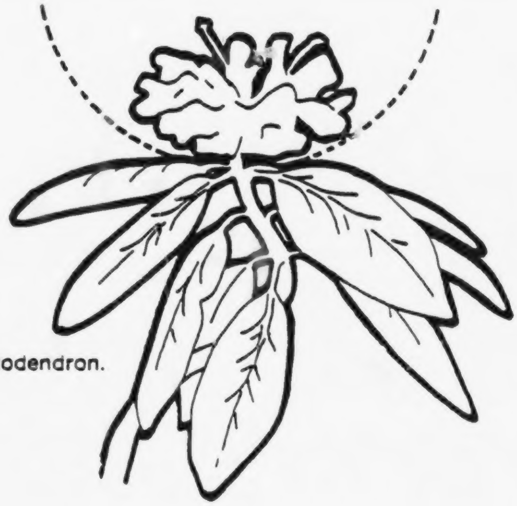


Figure 6-18. Removal of spent flowers from rhododendron.

EVALUATION:

1. The shrub was pruned to its natural shape. ______________
2. All undesirable branches (broken, diseased, or insect-infested) were removed. ______________
3. Spent flowers were removed. ______________
4. All debris was cleaned up. Tools were properly cleaned and stored. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-I

PRUNING HEDGES

Creating a hedge requires close spacing of shrubs at planting time and a special type of pruning. A hedge should be level on top and broader at the base than at the top. For a full hedge it is important that sunlight be able to reach the lower portion of the plants. Pruning should begin when plants are small. They should be cut back a little each time to increase density and attain the desired shape. It may be necessary to prune two or three times during the growing season. In this exercise you will demonstrate your ability to prune a hedge.

MATERIALS:

- hand hedge shears
- electric hedge shears
- hand pruning shears
- leather gloves
- knife
- leaf rake
- wooden stakes
- string

Safety notes on hand and electric hedge shears:

1. Remove all foreign material from the cutting area.
2. Make sure the equipment is in safe operating condition.
3. Check that cutting surfaces are clean, dry, and well sharpened.
4. Wear gloves while operating or cutting.
5. Do not cut wire or other materials.

PROCEDURE:

1. Select and assemble the necessary tools and materials.
2. Determine whether the hedge is deciduous or evergreen.
3. If necessary, place wooden stakes at each end of the hedge. Stretch strings the length of the hedge at the desired height to serve as guides and insure uniformity.
4. Cut any dead or broken branches back to a bud or side branch.
5. Prune formal and informal hedges to desired shapes (Figure 6-19). *Be careful!* To obtain a particular shape, **think first** how you want the hedge to look when you are finished. Then start pruning.
6. Prune the base wider than the top. Remove excessively wide side shoots which destroy the lines.

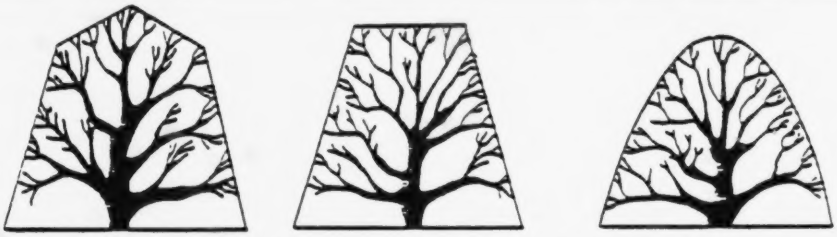


Figure 6-19. Forms of hedges pruned to insure good dense growth from top to bottom.

(continued)

Student Exercise 6-I *(continued)*

7. Remove clippings, stakes, and strings from the site.
8. Clean and store all equipment and materials.

EVALUATION:

1. The top of the hedge is straight and even. ______________
2. The base of the hedge is broader than the top. ______________
3. Excessively long branches were removed from the sides. ______________
4. All debris was cleaned up. Tools and materials were cleaned and stored. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-J

PRUNING ROSES

Roses need pruning to control size, to tidy up their appearance, and to improve health, growth habits, and bloom. Pruning methods vary according to the type of plant. Frost-injured wood on any plant should be removed to the first green bud or to a point where the bark is healthy. There is much controversy about the proper time and way to prune roses. Most experts agree that hybrid teas, floribundas, polyanthas, and grandifloras should be pruned in early spring to insure maximum flower production in the summer. Climbing roses should be pruned immediately after flowering to prevent removal of flower buds for the following year. In this exercise you will demonstrate your ability to prune roses.

MATERIALS:

- hand pruning shears
- leather gloves

Safety notes on hand pruning shears:

1. Keep shears latched or closed when not in use.
2. When in use, keep free hand away from cutting edges.
3. Do not overstress shears by trying to cut material that is too large.
4. Do not cut wire or other materials.

PROCEDURE:

1. Select and assemble the necessary tools and materials.
2. Remove all winter-damaged or dead wood. Cut back at a 45° angle to the first live green bud pointing towards the outside of the plant.
3. Remove all canes that are smaller in diameter than a pencil.
4. Open up the center of the bush by removing all branches that cross through the center.
5. Remove one of two canes which are rubbing.
6. Remove any broken or damaged canes.
7. Clean up all clippings from the job site.
8. Clean and store equipment.

EVALUATION:

1. All winter-damaged wood was cut back to live green buds. ______________
2. All small canes were removed. ______________
3. The center of the bush was opened up. ______________
4. All damaged or rubbing canes were removed. ______________
5. All clippings and debris were removed from the work site. Tools and equipment were cleaned and stored. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-K

PRUNING VINES

Vines usually need pruning to limit growth, to thin stems and branches, and to remove dead or damaged wood. Some vines grow so fast and thick that considerable pruning may be needed. Other vines need little pruning. Most vines may be pruned in the winter. You will demonstrate your ability to prune these vines properly.

MATERIALS:

- hand pruning shears
- leather gloves
- leaf rake

PROCEDURE:

1. Select and assemble the necessary tools and equipment.
2. Cut dead, diseased, and damaged vines back to healthy wood.
3. Cut back any branches that interfere with other plants or objects. Cut below the point of interference or back at the junction with the main stem.
4. Prune out the top one-third of overgrown or elongated stems.
5. Prune one-third or more of the old mature stems that are declining in vigor.
6. Clean up all clippings from the job site.
7. Clean and store equipment.

EVALUATION:

1. All dead, damaged and diseased wood was removed. ____________
2. The plant was pruned back to within desired boundaries. ____________
3. All clippings and debris were removed from the work site. All tools and equipment were cleaned and stored. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-L

HARVESTING NURSERY STOCK

Many nursery plants are harvested by the balling and burlapping method. With this method plants are dug with soil balls attached to the root systems. The soil ball is then wrapped with burlap. In this exercise you will harvest nursery stock using the balling and burlapping method.

MATERIALS:

- spade
- twine
- burlap
- nursery pinning nails

PROCEDURE:

1. Locate the plant to be harvested.
2. Loosely wrap the plant with twine to keep branches out of the way of diggers.
3. Remove debris from the top of the soil directly around and under the plant.
4. Mark off the diameter of the ball with a spade. Remember that ball sizes should always be large enough to insure a full recovery of the plant.
5. Cut some branching roots with a spade. Removal of these roots will not harm the plant if the root system is large enough.
6. When the soil has been removed from around the ball, place two squares of burlap loosely around the top of the ball.
7. Secure the burlap around the ball and pin with nursery pinning nails.
8. Reach underneath the ball and cut the tap roots with a spade.
9. Once the tap roots have been cut, tilt the ball. Then place the ball on the square of burlap.
10. Attach the bottom square of burlap to the side of the tilted ball. Once the burlap is securely attached, tuck the remaining loose flap under the tilted ball.
11. Pull the flap of burlap up and over the entire bottom of the ball. Fasten it around the remaining part of the ball.
12. Remove the ball gently from the hole.
13. Rope the ball for additional stability during handling.
14. Transport ball to permanent location.

EVALUATION:

1. Exercise was completed as directed. ____________
2. All materials and equipment used were cleaned and stored properly. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 6-M

WATERING

Watering crops is an important operation in a nursery. To be an effective nursery worker, you need an understanding of the various types of irrigation equipment and irrigation practices used in different growing situations. In this exercise you will gain some practical experience in watering crops.

MATERIALS:

- hose
- breakers
- crops to be watered

PROCEDURE:

1. Select crops in various stages of maturity.
2. Select appropriate watering equipment for each crop. For example, seedlings are generally watered with some type of fog or mist nozzle.
3. Determine the appropriate time to water the plants by observing the soil color and appearance, by the weight of the container, or by touch.
4. Water the plants.

EVALUATION:

1. Appropriate irrigation equipment for each crop was selected. ____________
2. The correct time to water each crop was determined. __________
3. Plants were watered properly with sufficient water applied to drain through the containers.

____

FINAL GRADE ________

NAME ____________________

QUIZ - CHAPTER 6

TRUE OR FALSE

Read each statement correctly. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. Bedding plants must be transplanted only into plastic market packs.

T F 2. Plants must be removed from Jiffy-7's before transplanting.

T F 3. You should always handle seedlings by the stem, not the leaves.

T F 4. Watering is a very important step in transplanting.

T F 5. Hardening off is the process of acclimating plants to outdoor conditions.

T F 6. Plants set out in the field may be propagated only from cuttings.

T F 7. Fields must be adequately prepared before transplanting so that roots can develop properly in the soil.

T F 8. Plants should be planted deeply so that all air is excluded from the roots.

T F 9. Newly planted material must never be fertilized.

T F 10. Whips are unbranched tree shoots resulting from budded or grafted understocks of cutback seedlings.

T F 11. Most nurseries stake plants only if they absolutely need it.

T F 12. Pruning is the selective removal of plant parts.

T F 13. A tree which has been "limbed up" has had its lower branches removed flush with the trunk.

T F 14. If pruning is done too early in the growing season, the plant's food production is cut back drastically.

T F 15. When pruning, you should avoid leaving small stubs where healing may not take place.

T F 16. You should prune pines by pinching off 6 inches below the candle growth.

T F 17. Evergreens should never be thinned out.

T F 18. Deciduous vines never require heavy pruning or complete cutback.

T F 19. *Off-Shoot-O* is a chemical pinching agent.

T F 20. After the initial watering of newly planted stock, the soil should be allowed to dry out completely.

T F 21. In temperate regions harvesting usually begins immediately after the first light frost.

T F 22. Most budding knives have a curved blade.

T F 23. It is important to sharpen budding knives regularly.

T F 24. Spades are the most popular hand tool for cultivation and weed control.

T F 25. Some large nurseries find it efficient to use helicopters for spraying.

(continued)

QUIZ - page 2

MULTIPLE CHOICE

Read each item and decide which choice answers the question or completes the statement. Circle the letter of the correct answer.

26. Bedding plants do best when grown in a temperature ________ degrees lower than that required for germination.

    A. 1 to 2
    B. 5 to 10
    C. 15 to 20
    D. 30

27. The correct size container for a plant should be based upon:

    A. type of plant
    B. size to which plant will be grown
    C. storage area available
    D. all of the above

28. Bedding plants should be transplanted as soon as the ________ pair of true leaves develops.

    A. first
    B. second
    C. third
    D. fourth

29. The chemical responsible for apical dominance is:

    A. a pyrethroid
    B. agar
    C. an auxin
    D. vermiculite

30. Which of the following is **not** a general procedure to follow in pruning any plant?

    A. Remove dead or broken branches.
    B. Remove branches which cross.
    C. Remove the central leader.
    D. Remove diseased or insect-infested branches.

31. Rejuvenate old overgrown shrubs by:

    A. cutting them back to the ground
    B. removing the central leader
    C. lightly thinning the top
    D. snapping or cutting out dead flowers

32. Spring flowering shrubs such as forsythia should be pruned:

    A. soon after flowering
    B. in late summer
    C. in autumn
    D. in mid-winter

33. Hybrid tea roses should be pruned:

    A. before spring growth
    B. after spring growth
    C. in later summer
    D. in early autumn

34. Plants trained to grow decoratively along a railing or trellis are called:

    A. whips
    B. bridge grafts
    C. liners
    D. espaliers

35. A simple rule-of-thumb for watering established field stock is to apply:

    A. 1 inch of water every day
    B. 1 inch of water every 5 days
    C. 1 inch of water every 10 days
    D. 5 inches of water every week

36. Which of the following is an advantage of balling and burlapping nursery stock?

    A. The root system is relatively undisturbed.
    B. Plants can be harvested almost any time of year.
    C. Plants remain in a growing condition after harvesting.
    D. All of the above.

(continued)

QUIZ - page 3

37. Which of the following would probably **not** cause a tractor to overturn?

A. crossing a ditch
B. keeping tractor in good mechanical condition
C. making a sharp turn at high speed
D. hitting a hidden object

38. The most commonly used espalier is the . . .

A. double cordon
B. double-U
C. tiered cordon
D. palmette

39. Forsythia, lilac, mockorange and spirea need to be pruned . . .

A. three months before flowering
B. during flowering
C. immediately after flowering
D. in early autumn

40. Which of the following pruning procedures would result in a more natural plant appearance?

A. topping
B. shearing
C. thinning
D. wicking

41. An apically dominant plant is . . .

A. one which must be shaped
B. one which has a main terminal
C. an evergreen shrub
D. none of the above

42. A hedge should be pruned so that . . .

A. the top is wider than the bottom
B. the bottom is wider than the top
C. the top and bottom are equal in width
D. none of the above

43. Which of the following types of nursery containers would probably break most easily?

A. market packs
B. plastic pots
C. clay pots
D. metal cans

44. Which of the following is **not** an advantage of balling and burlapping?

A. Roots are relatively undisturbed.
B. There is less shock to the plants.
C. Plants remain dormant after harvesting.
D. Plants can be harvested almost any time of year.

45. Pruning is needed to . . .

A. limb up trees so mowing is possible
B. create a desirable shape
C. make an evergreen full and bushy
D. accomplish all of the above

46. A major disadvantage of using bareroot plant material is . . .

A. It is lighter in weight than balled-and-burlapped stock.
B. It is cheaper to ship than balled-and-burlapped stock.
C. There is greater shock to the plant.
D. Both A and C.

47. The proper size container for nursery stock is based on . . .

A. the type of plant
B. the amount of time available for transplanting
C. the storage area available
D. both A and C

ANSWER KEY - CHAPTER 6

Key Questions, Part 1 - page 6-3

TRANSPLANTING

1. Annuals should be transplanted carefully so as not to damage roots. If roots are matted together they can be dipped in water to separate.
2. Annuals are transplanted as soon as the first pair of true leaves develops.
3. Annuals are grown in peat strips and pots, plastic pots, market packs, Jiffy-7's, and sometimes clay pots.
4. To transplant liners into the field properly:

   (1) Land should be adequately prepared before transplanting.
   (2) Plants should be set at the proper depth.
   (3) Soil should be packed around the transplants.
   (4) Transplants should be watered immediately.
   (5) Transplants should be fertilized as soon as possible.
5. Jiffy-7's combine the functions of a pot and potting soil in one unit. The entire pellet containing the root system can be planted in the ground, thus avoiding transplant shock.
6. Annuals are "hardened off" to acclimate plants to outdoor conditions.

STAKING

7. Nursery plants are staked so they will grow straight and, in some cases, to prevent bud blow-off.
8. Nursery plants are tied to stakes with plastic ties or twistems.

Key Questions, Part 2 - page 6-4

PRUNING

1. *Apical dominance* refers to a condition in which an auxin (chemical or hormone) prevents the growth of buds below the apical (tip) bud. When the apical bud is removed, plants will branch.
2. Shade trees should have removed from them any branches which interfere with foot or vehicle traffic. Tops should be thinned to provide internal branches with light. The central leader is generally *not* cut. When possible, two small cuts are made, followed by a large cut.
3. Deciduous shrubs should be thinned by cutting back branches selectively. Generally they are pruned shortly after flowering.
4. Narrowleaf evergreens are cut back in early spring prior to growth. Pines are pruned by pinching off in the middle of the candle growth. Thinning is needed occasionally.
5. Relatively little pruning is necessary with broadleaf evergreens.
6. Rose canes are cut back as little as necessary, generally before spring growth. Climbers are pruned after flowering.
7. An espalier is a plant trained to grow decoratively along a railing or trellis.

Key Questions, Part 3 - page 6-5

IRRIGATION

1. Irrigation is the practice of providing supplemental water to plants.
2. Sprinkler irrigation is most often used by nursery operators.
3. Apply one inch of water every ten days.
4. Different types of nozzles are used to water container stock. Also, since there is less soil in containers, plants must be watered more frequently.

(continued)

Answers *(continued)*

HARVESTING

5. Bareroot stock is generally harvested mechanically, then tied in bundles.
6. Advantages of B & B plants include:

   (1) The root system is relatively undisturbed.
   (2) Plants can be harvested almost any time of the year.
   (3) Plants remain in growing condition after harvesting.
   (4) There is less shock to plants at transplant time.

7. Neither method can be considered better. There are times when one method is preferred over the other. Generally, B & B plants suffer less shock than do bareroot plants.

Key Questions, Part 4 - page 6-6

TOOLS AND EQUIPMENT

1. Hand tools used in a nursery include: budding knives, pruning knives, grafting knives, hand pruning shears, hoes, hand cultivation tools, shovels, and spades.
2. Spades are sharp. They are used to cut feeder roots when digging plants. Shovels are used primarily for lifting and moving soil, etc.
3. Tractors are used for tilling, raking, planting, harvesting, fertilizing, mowing, shredding, spraying, aerating, using a dozier blade, and moving snow.
4. Tractor safety is important because a tractor can be dangerous when not used properly.
5. Accidents with tractors can be avoided by:

   (1) Backing out, if possible, when stuck in a hole or soft spot.
   (2) Avoiding steep banks.
   (3) Keeping the drawbar at the recommended height.
   (4) Driving slowly when vision is limited or when on rough ground.
   (5) Slowing down before turning.
   (6) Staying alert when driving on the highway.
   (7) Keeping the load close to the ground when moving the tractor and using adequate wheel weights.
   (8) Always operating with the PTO shield in place and shutting off the power before dismounting from the tractor.
   (9) Carrying only the driver — never any riders.
   (10) Keeping the tractor in good mechanical condition.

QUIZ

True or False - page 6-33

1. false
2. false
3. false
4. true
5. true
6. false
7. true
8. false
9. false
10. true
11. true
12. true
13. true
14. true
15. true
16. false
17. false
18. false
19. true
20. true
21. true
22. true
23. true
24. false
25. true

Multiple Choice - page 6-34

26. B
27. D
28. A
29. C
30. C
31. A
32. A
33. A
34. D
35. C
36. D
37. B
38. B
39. C
40. C
41. B
42. B
43. C
44. C
45. D
46. C
47. D

Terms to Remember, Part 1 - page 6-7

1. leggy
2. apical dominance
3. espalier
4. hone
5. oilstone
6. transplant
7. shovel
8. spade
9. hybrid tea
10. seeding
11. annual
12. liner

Terms to Remember, Part 2 - page 6-8

1. limbing up
2. perennial
3. arborist
4. lining out
5. auxin
6. bedding plant
7. cane
8. leader
9. hardening off
10. grandiflora
11. Jiffy-7
12. mechanization

(continued)

Answers *(continued)*

Crossword Puzzle 6 - page 6-11

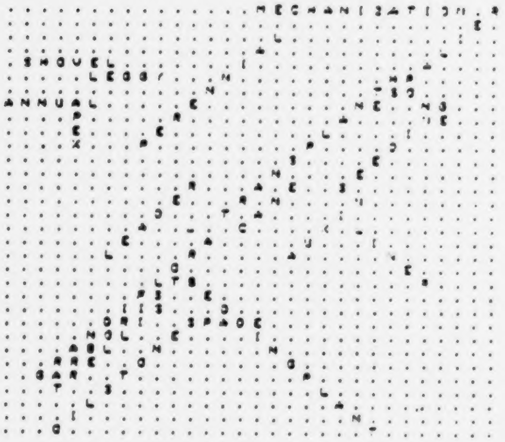
ACROSS

5. perennial
8. burlap
9. liner
10. auxin
13. hybrid
15. arborist
16. transplant
18. shovel
19. cane
20. annual
22. espalier
23. floribunda
24. oilstone

DOWN

1. bedding plants
2. leader
3. leggy
4. mechanization
6. bareroot
7. tractor
11. deciduous
12. flat
14. photosynthesis
17. seeding
20. apical
21. spade

Letter Maze 6 - page 6-9



GLOSSARY - Chapter 6

annual - a plant that completes its life cycle in one year.

apical dominance - the apical (tip) bud causes a chemical hormone (auxin) to be produced in the plant. This hormone prevents the growth of buds below the apical bud. When the apical bud is removed, the hormone is no longer present, and the side buds will grow.

arborist - a specialist in the care and maintenance of trees.

auxin - a chemical growth hormone found in plants.

bedding plant - annuals, or plants handled as annuals, which are grown to transplant size and then sold to consumers who plant them directly in the outdoor landscape.

cane - a rose stem

deciduous - trees or shrubs which shed their leaves during the dormant (winter) season.

espalier - a method of training plants to grow decoratively along a railing, trellis, or wall.

flat - a tray for carrying plants.

floribunda - a type of rose plant with smaller blossoms than those of hybrid tea, but the blossoms may be twice as numerous as those of hybrid teas. Also known as "sweetheart roses."

grandiflora - a type of rose plant with large single flowers like hybrid tea blooms. Flowers are somewhat smaller and more numerous than those of hybrid teas.

hardening off - a process of acclimating plants to outdoor conditions.

hone - a stone used for sharpening knives, etc.; or to sharpen a knife.

hybrid tea - a type of rose plant with large single flowers borne on long stems.

Jiffy-7 - a compressed peat pellet which combines the functions of a pot and potting soil in one unit.

leader - the terminal or primary shoot of a plant.

leggy - spindly or elongated growth.

limbed-up - the process of removing lateral tree branches that have sprouted near the ground.

liners - young plants grown in rows in the field.

lining out - placing young plants in rows in the field.

mechanization - the process of replacing human labor with equipment.

oilstone - a whetstone used with oil to hone (sharpen) tools.

perennial - a plant that continues to live from year to year. In cold climates, the tops may die, but the roots and rhizomes persist.

seeding - sowing seed.

shovel - a long-handled scooplike implement used to lift and throw soil.

spade - a digging tool, heavier than a shovel, adapted for being pushed into the ground with the foot.

transplant - the process of shifting a plant from one container or location to another.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 6

T6-1 *(Student Manual*, pages 126-127)

Bedding plants can be transplanted into a wide variety of containers. Most nursery operators prefer containers made of lightweight plastic or molded peat. These containers are sold with the plants, so the container price is included in the plant price.

Question: Why aren't many bedding plants marketed in clay pots?

T6-2 *(Student Manual*, page 127)

Regardless of whether the plant to be grown in a container is a seedling or a rooted cutting (liner), the transplanting process is similar. Place the soil mix directly into the can and fill it about 2/3 full. To remove the plant from the pot, hold the plant stem between spread fingers. Turn it upside down and strike the pot rim against the edge of the bench to loosen and remove the plant.

Question: How do you determine the correct size container to use?

T6-3 *(Student Manual*, page 132)

The apical or tip bud of a plant causes an auxin (chemical hormone) to be produced in the plant. This auxin prevents the growth of the buds below the apical bud. When the apical bud is pruned, the auxin is no longer present in the stem and the lateral buds then begin to grow.

T6-4 *(Student Manual*, page 134)

This figure illustrates the proper cutting technique to use when pruning plants.

T6-5 *(Student Manual*, page 134)

If possible, make two small cuts followed by one large cut when removing limbs over 4 inches in diameter.

Question: Why should you make three cuts when pruning large limbs?

T6-6 *(Student Manual*, pages 134-135)

When pruning shrubs, don't simply trim back the top. It is important to thin out the plant by cutting back the branches selectively. Cut off these branches where they are attached to the trunk or main stem.

Question: Why shouldn't you simply trim back the top?

T6-7 *(Student Manual*, page 135)

To rejuvenate old overgrown or unhealthy deciduous shrubs you can cut them back to the ground in late winter. Examples of shrubs which can be pruned in this way are forsythia, lilac, mockorange, and spirea.

Question: Why is winter the recommended time for this procedure?

Narratives for Transparency Masters *(continued)*

T6-8 *(Student Manual*, page 135)

It is difficult to prune firethorn without eliminating last year's fruits, plus flowers and fruits for next year. Annual light pruning insures flowers and fruits each year.

Question: When should shrubs such as firethorn be pruned?

T6-9 *(Student Manual*, page 135)

Snap or cut out dead flowers of rhododendron, being careful not to damage new growth. This will insure optimum flowering for the next season.

Question: What are some other shrubs which should have their flowers removed to insure flowering the following season?

T6-10 *(Student Manual*, page 136)

Yearly pruning is needed to maintain a compact habit in narrowleaf evergreens. Cut back ¼ to ½ of the previous year's growth on narrow uprights. On pyramidal plants, cut back just enough to maintain compact growth.

T6-11 *(Student Manual*, pages 136-137)

Dead, broken, and diseased or insect-infested canes should be removed. Also remove canes which cross or ruin the shape of the plant. Cut back the remaining canes as little as necessary or 18-25 inches in height.

Questions: When should you prune hybrid tea roses? Floribundas and grandifloras? Climbers?

T6-12 *(Student Manual*, page 137)

Climbing roses should be pruned by removing dead canes and non-prolific, old canes. You can keep these plants in bound by cutting back the long trailing canes.

T6-13 *(Student Manual*, page 137)

Hedges should be pruned so that the base of the hedge is wider than the top. This allows light to reach lower branches and helps prevent "legginess."

Questions: When should hedges be pruned? How often?

T6-14 *(Student Manual*, page 137)

Remove weak, V-shaped crotches when the tree is young. Branches with a narrow-angle attachment are more likely to split.

T6-15 *(Student Manual*, page 138)

Espaliers are plants trained to grow decoratively along a railing or trellis. They are generally restricted to several shoots growing in opposite or parallel directions. Although this is a popular gardening hobby, espalier pruning is not a major part of a nursery operation.

Narratives for Transparency Masters *(continued)*

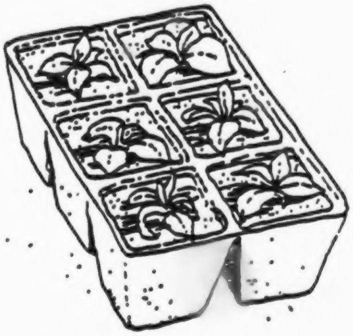
T6-16 *(Student Manual*, page 141)

This is an illustration of one method of watering used by nursery operators who have a lot of container-grown stock. One end of a plastic tube is attached to a special hose and the other end is inserted in each individual container. When the water is turned on, each container receives water.

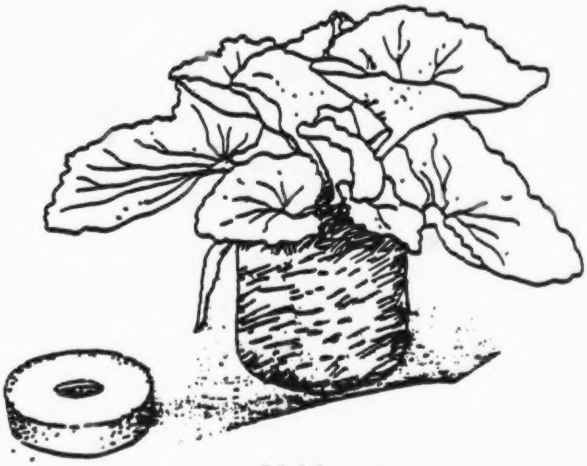
T6-17 *(Student Manual*, page 141)

A dribble ring is often used in nursery cans and large pots to insure even watering. This system has advantages over sprinkler irrigation in lower water consumption and less water runoff.

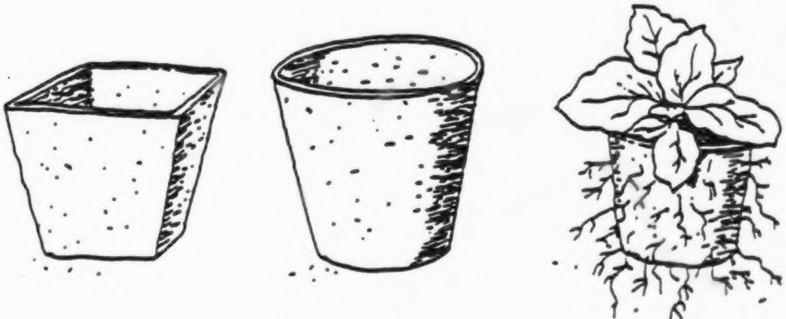
Containers



Peat Strips



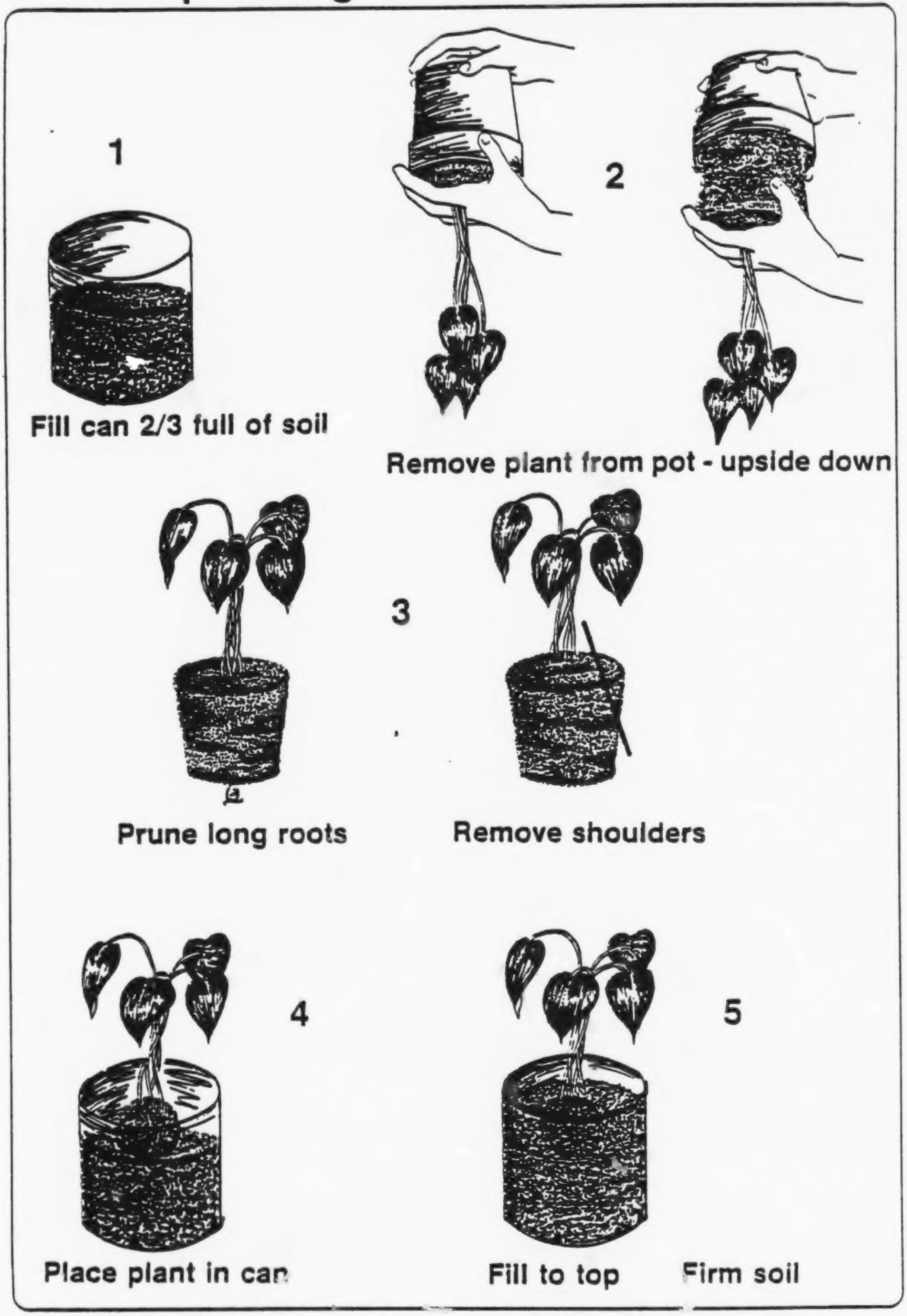
Jiffy-7



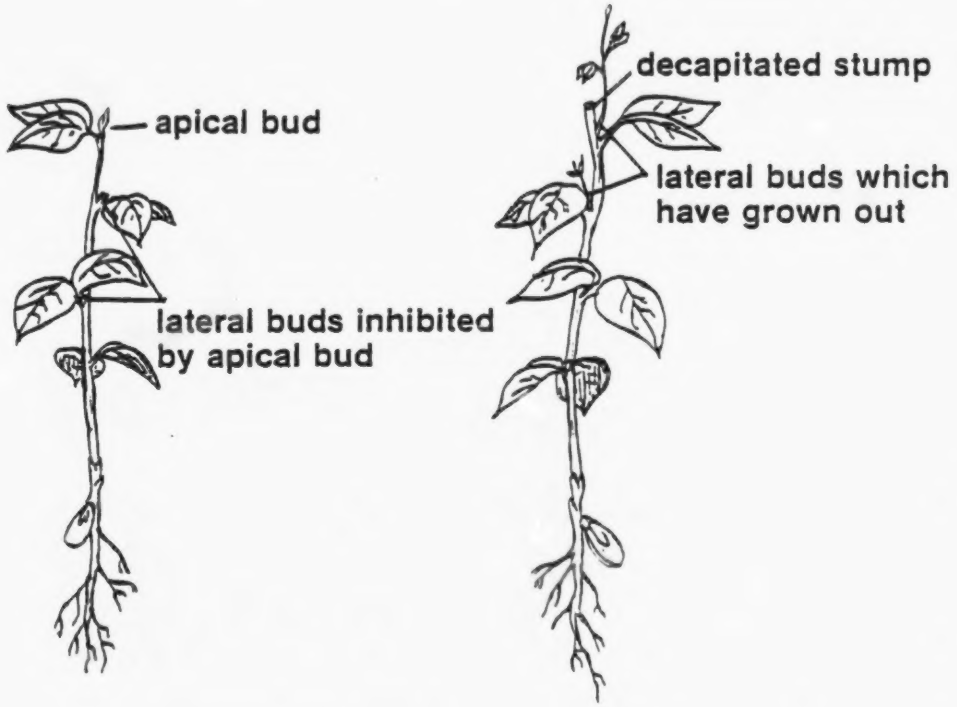
Peat Pots

T6-2

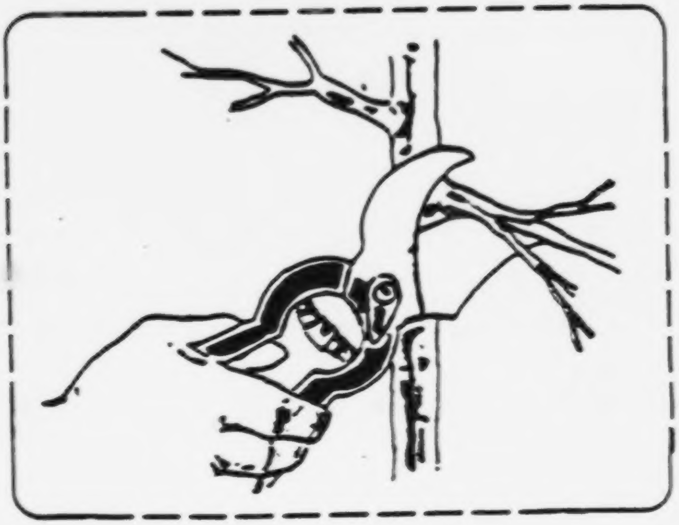
Transplanting Liners into Containers


1
Fill can 2/3 full of soil
2
Remove plant from pot - upside down
3
Prune long roots
Remove shoulders
4
Place plant in can
5
Fill to top
Firm soil

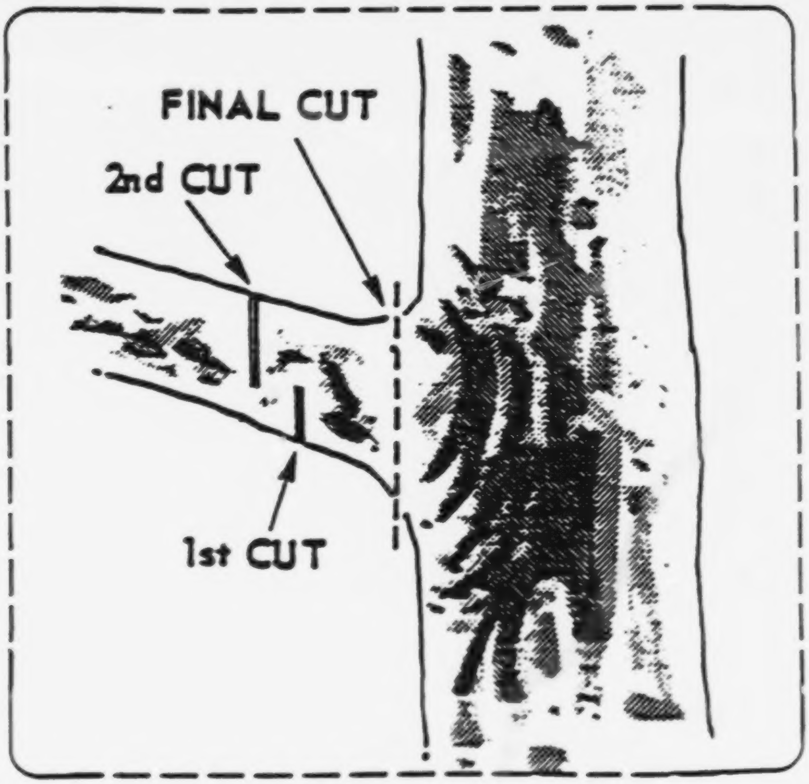
The Effect of Apical Dominance — before and after removal of apical bud


apical bud
lateral buds inhibited by apical bud
decapitated stump
lateral buds which have grown out

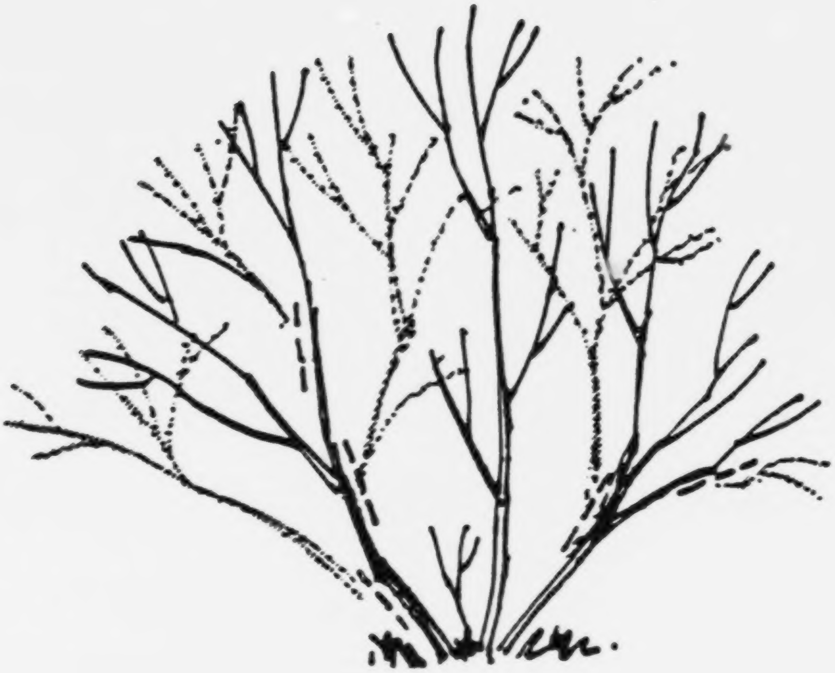
Proper Cutting Technique



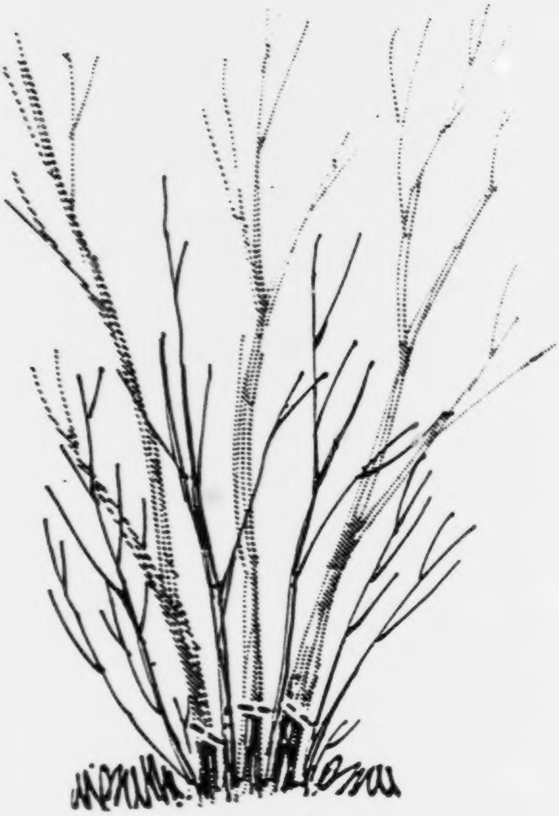
When removing large limbs, three cuts are necessary to prevent bark tearing.


FINAL CUT
2nd CUT
1st CUT

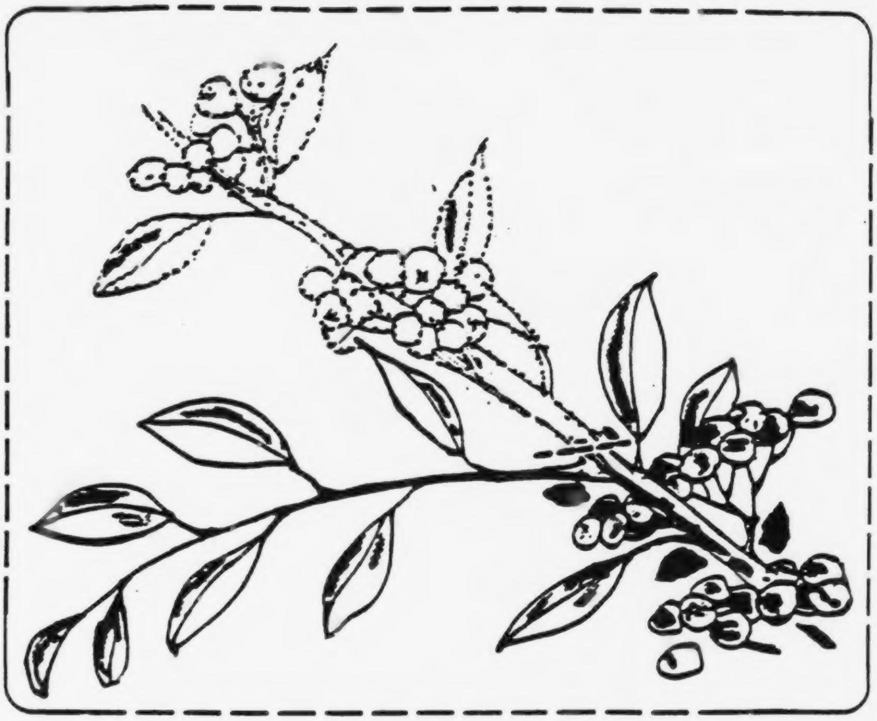
Light shaded branches and dotted lines show how deciduous shrubs are thinned.



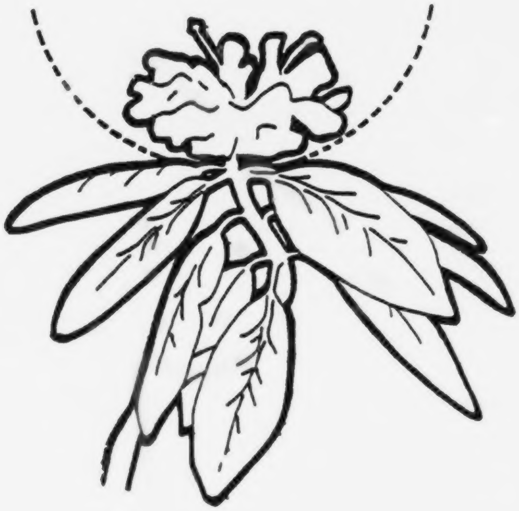
To rejuvenate an overgrown or unhealthy deciduous shrub, cut completely back to the soil in late winter.



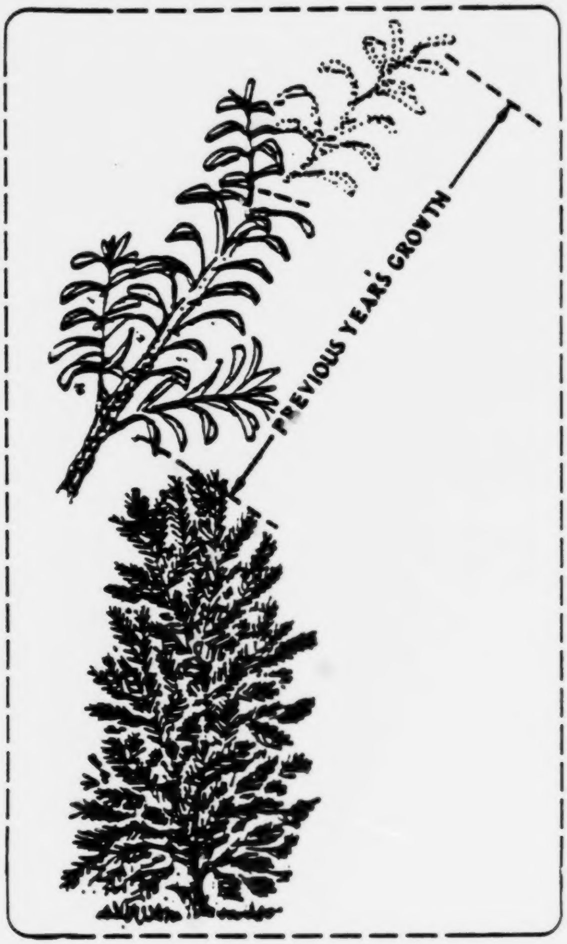
Prune firethorn without eliminating last year's fruits plus flowers and fruits for the next year.



Carefully snap or cut out dead flowers of rhododendron.

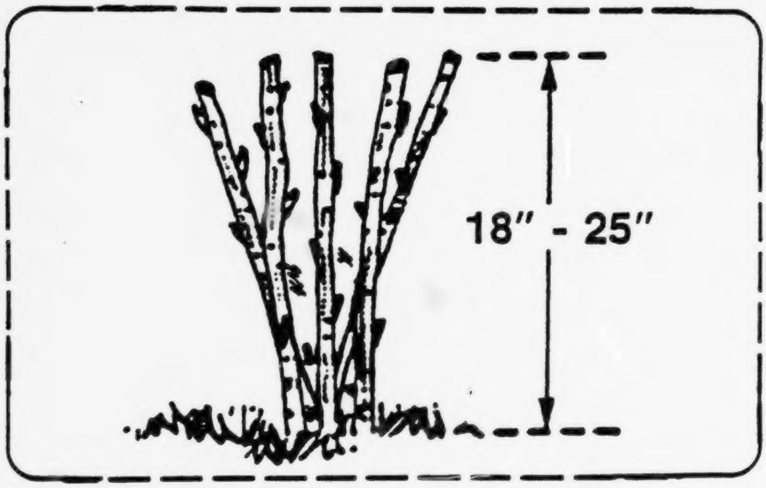


Cut back ¼ to ½ of previous year's growth on narrow uprights. On pyramidal plants, cut back just enough to maintain compact growth.

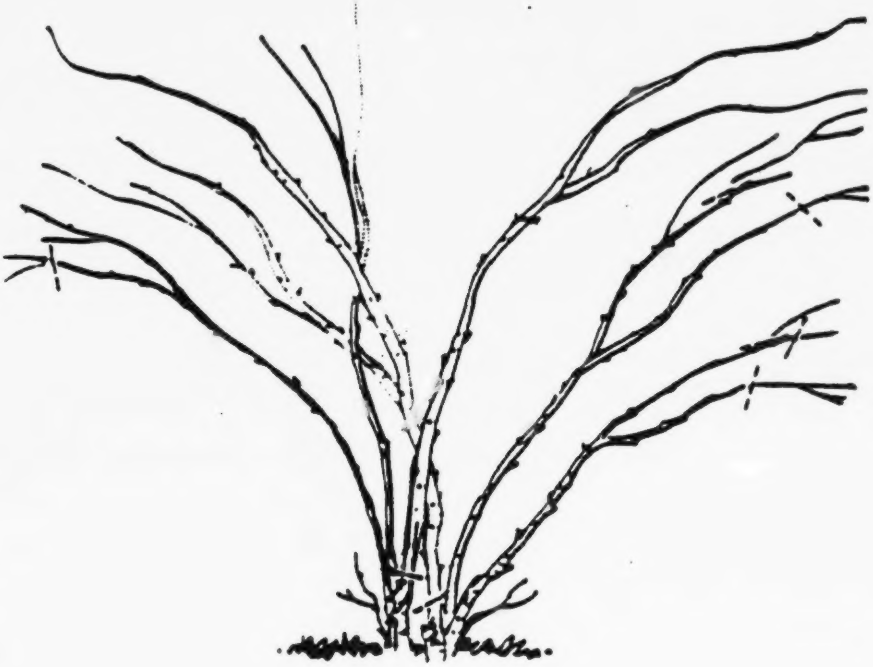

PREVIOUS YEAR'S GROWTH

321

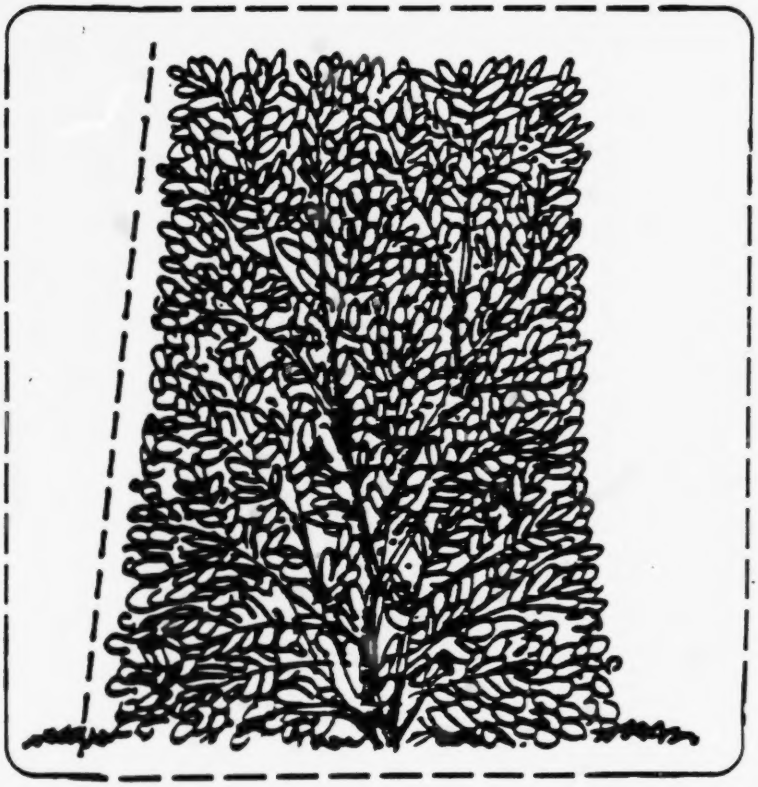
Cut back canes of roses not damaged by winter to 18 to 25 inches or to a height in balance with other plants.



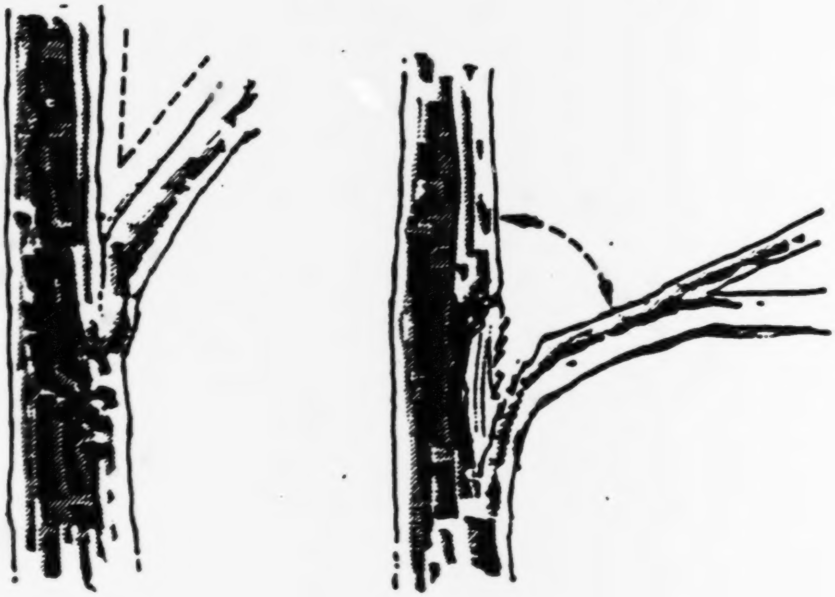
Prune climbing roses by removing dead canes and non-prolific, old canes. Keep in bounds by cutting back long, trailing canes.



Prune hedge so base is broader than top.

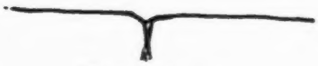


A branch with a narrow-angle attachment is more likely to split.

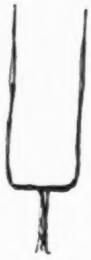


325

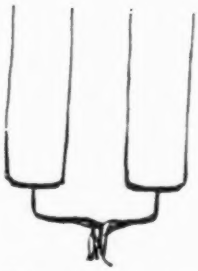
Espalier Patterns



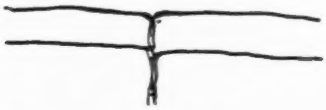
Cordon



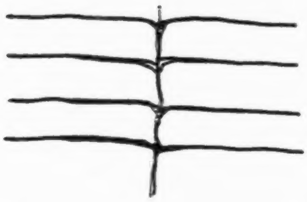
U



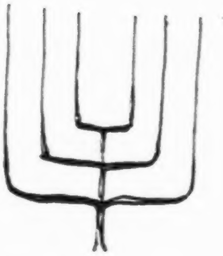
Double-U
(most common)



Double Cordon

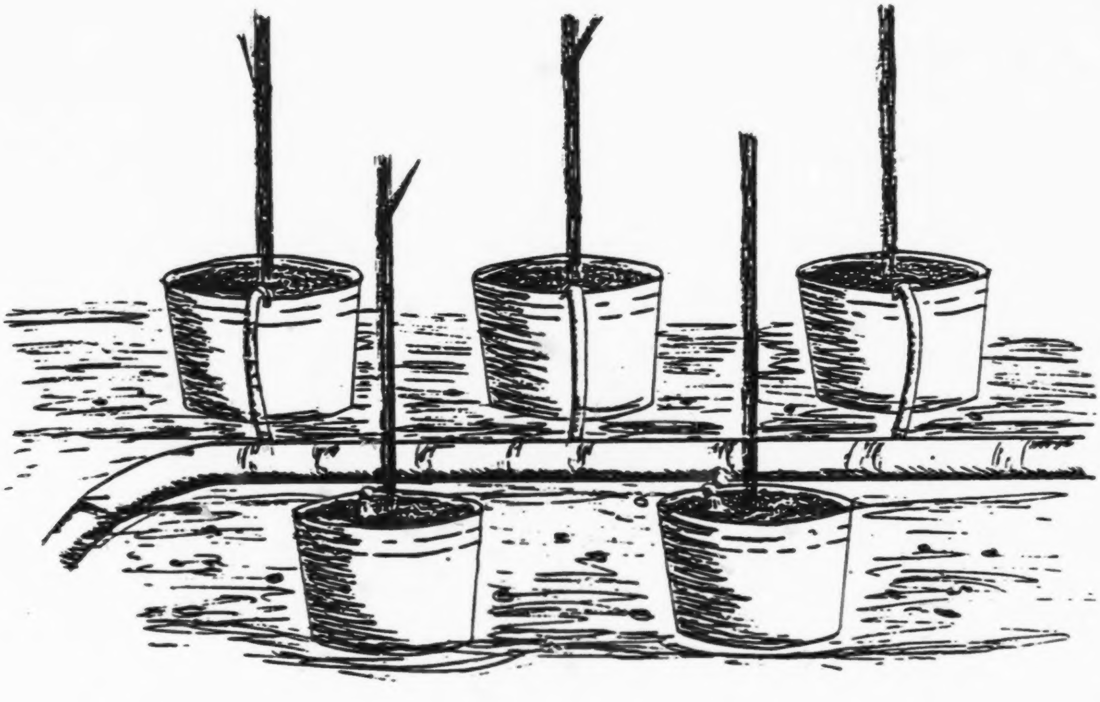


Tiered Cordon



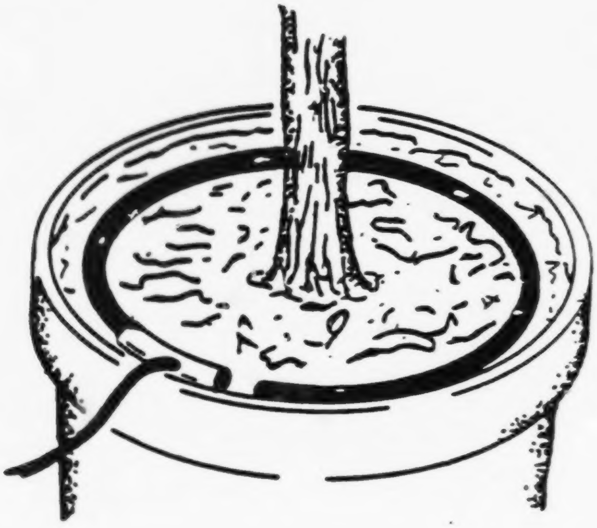
Palmette

Individual Plastic Tubes Secured to Containers for Watering



327

Dribble Ring Used for Nursery Cans and Large Pots



CHAPTER 7

CONTROLLING PESTS

PERFORMANCE CHECK LIST

1. Differentiate between harmful and beneficial insects.
2. Identify the major body parts of an insect.
3. Differentiate between chewing and piercing-sucking mouthparts in insects.
4. Describe the four types of metamorphosis taking place in insect development.
5. Explain how knowing insect life cycles can help nursery workers.
6. Recognize the damaging stage of some insect pests.
7. List five ways insects can be controlled.
8. Describe the process for introducing a new chemical.
9. List the three steps used in controlling insects and related pests.
10. Differentiate between disease susceptibility and disease resistance in plants.
11. Identify common plant diseases caused by bacteria.
12. Describe the reproductive and plant-damaging processes of fungi.
13. Differentiate between viruses and mycoplasmas.
14. Describe the reproductive cycle of nematodes.
15. Explain the difference between pathogenic and non-pathogenic diseases in plants.
16. List four steps for controlling plant diseases.
17. Demonstrate the process for mailing a plant disease specimen to a plant disease clinic.
18. Use a trouble-shooting key for ornamental tree diseases.
19. Use plant disease references for obtaining control recommendations for specific diseases.
20. Describe the damage done to nursery stock by rabbits.
21. Describe the damage done to nursery stock by deer.
22. Describe the damage done to nursery stock by mice and rats.
23. Control animal pests in a nursery.
24. Describe the three major steps in a weed control program.
25. Use physical methods to control weeds.
26. Differentiate between selective and nonselective herbicides.
27. Differentiate between contact and translocated herbicides.
28. Explain why timing is important when applying herbicides for weed control.
29. Use appropriate measures for cleaning and storing herbicide application equipment.
30. Describe situations where soil fumigation or pasteurization might be advisable.
31. Differentiate among stomach, contact, and systemic poisons.
32. Differentiate among insecticides, miticides, nematocides, fungicides, and rodenticides.

33. Demonstrate the proper steps to follow when selecting a pesticide.
34. Demonstrate precautions to be taken when handling and mixing pesticides.
35. Demonstrate precautions to be taken when applying pesticides.
36. Demonstrate the proper procedure for disposing of surplus pesticides and containers.
37. Demonstrate the proper procedure for storing pesticides.

SUGGESTED LEARNING ACTIVITIES

1. Have students collect and mount insects from around the home and school. Identify these insects and determine if they are harmful or beneficial.
2. Have students role-play as customers and sales clerks in a commercial nursery or garden center. Have the "customers" ask the "sales clerks" to identify various pests and pest damage and recommend the proper controls.
3. Have students collect weeds from around the home and school. Identify these weeds and select the appropriate herbicide for control or elimination.
4. Start a notebook of newspaper clippings about pests on landscape plants. The Sunday newspaper's garden section is a good place to start.
5. Invite a local tree-care specialist to the classroom for a discussion of last year's major pests in the local area. You might also have these specialists demonstrate commercial spray equipment.
6. Identify 10 insects according to their type of mouthparts. Also identify the type of damage caused by each insect.
7. Dissect a grasshopper and identify the following parts: abdomen, spiracles, metathorax, mesothorax, prothorax, wings, palpi, antennae, and eyes.
8. Visit a pesticide dealer or garden center and view the many different pesticides. Discuss how pesticides are displayed and merchandised.
9. Invite an "organic" or "natural" farmer or gardener to speak on controlling pests without pesticides. Debate chemical vs. non-chemical methods.
10. Maintain a collection of pest specimens and examples of damaged caused. Use bottles, mounts, pictures, and various containers to display these pests.
11. Subscribe to *Bug Dope* published by the Cooperative Extension Service, The Ohio State University, 1735 Neil Avenue, Columbus, OH 43210.
12. Have students apply herbicides to selected nursery beds, containers, and areas of the school landscape.
13. Develop a program of preventive spraying for pests found in the greenhouse.
14. Take a field trip to a local arboretum or park to observe plants and pests.

SAMPLE INTEREST APPROACH

Bring in a plant which has been noticeably damaged by insects or disease. Ask students, "Would you pay good money for this plant? Why? Why not? What if all of a nursery operator's plants were damaged like this one?"

Have the class study the damaged plant and try to determine: (1) the cause of the problem, (2) how to treat the existing problem, (3) how to prevent future problems. When students can't make these determinations, move into the unit on Controlling Pests or to a specific supervised study session.

NAME ____________________

KEY QUESTIONS FOR CHAPTER 7

PART 1

Insects and Related Pests

1. What is a pest? (page 151)

____

____

2. What is the study of insects called? (page 152)

____

3. Are all insects harmful? (page 152)

____

4. List the major parts of an insect's body. (page 152)

(1) ____________________

(2) ____________________

(3) ____________________

5. Why is it important to know what kind of mouthparts an insect has? (page 153)

____

____

6. What is metamorphosis? (page 153)

____

____

7. Why is it important for nursery operators to understand something about insect life cycles? (page 153)

____

____

8. Name 5 of the harmful insects which commonly infest nursery crops. (pages 157-164)

____

____

Insect and Mite Control

9. What is a pesticide? (page 165)

____

____

10. What is biological control? (page 164)

____

____

____

(continued)

Key Questions, Part 1 *(continued)*

11. What is cultural control? (page 165)

____

____

____

12. List 6 steps followed in screening and testing pesticides. (page 165)

(1) ______________________________________
(2) ______________________________________
(3) ______________________________________
(4) ______________________________________
(5) ______________________________________
(6) ______________________________________

NAME ____________________

PART 2

Plant Diseases

1. List the 7 steps in a successful control or management program for plant diseases. (page 167)

(1) ____________________

(2) ____________________

(3) ____________________

(4) ____________________

(5) ____________________

(6) ____________________

(7) ____________________

2. List 4 organisms that cause plant diseases. (pages 167-171)

(1) ____________________ (3) ____________________

(2) ____________________ (4) ____________________

3. What are the symptoms of fireblight on ornamentals? (page 168)

____

____

____

4. What are the symptoms of scab on ornamental crabapples? (page 169)

____

____

____

5. What is iron chlorosis and how can it be prevented? (pages 171-172)

____

____

____

6. List four general types of control for plant diseases. (page 174)

____

____

____

____

NAME ____________________

PART 3

Other Pests

1. How do rabbits damage nursery crops? (page 178)

2. How do deer damage nursery crops? (page 179)

3. How do mice and rats damage nursery crops? (pages 179-180)

4. How can animal pests be controlled in the nursery? (page 180)

NAME ______________________

PART 4

Weed Control

1. What is a weed? (page 183)

2. How does a selective herbicide differ from a nonselective herbicide? (page 184)

3. How does a contact herbicide differ from a translocated herbicide? (page 184)

4. How does a preemergence herbicide differ from a postemergence herbicide? (page 184)

5. What is a fumigant? (page 184)

6. List 6 items to consider before applying a herbicide. (pages 188-189)

(1) ______________________

(2) ______________________

(3) ______________________

(4) ______________________

(5) ______________________

(6) ______________________

7. What are surfactants and why are they used? (page 189)

8. What are adjuvants and why are they used? (page 190)

9. Why is it important to clean and store sprayers properly? (page 190)

NAME ______________________

PART 5

Safe Use of Pesticides

1. What is the difference between an insecticide and a pesticide? (page 191)

____

____

2. List the 9 steps to follow when handling and mixing pesticides. (pages 192-193)

(1) ____
(2) ____
(3) ____
(4) ____
(5) ____
(6) ____
(7) ____
(8) ____
(9) ____

3. List the 11 steps to follow when applying pesticides. (pages 193-194)

(1) ____
(2) ____
(3) ____
(4) ____
(5) ____
(6) ____
(7) ____
(8) ____
(9) ____
(10) ____
(11) ____

4. List the 8 steps to follow when disposing of surplus pesticides and containers. (page 194)

(1) ____
(2) ____
(3) ____
(4) ____

(continued)

Key Questions, Part 5 *(continued)*

(5) ____

(6) ____

(7) ____

(8) ____

5. List the 5 steps to follow when storing pesticides. (page 194)

(1) ____

(2) ____

(3) ____

(4) ____

(5) ____

NAME ____________________

TERMS TO REMEMBER - Chapter 7

PART 1

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 7 of *The Nursery Worker*.

Technical Vocabulary

adjuvant
biological control
calibrate
contact herbicide
dormant
entomology
grub
herbicide
mycoplasma
nematode
nymph
plant pathology
preplant herbicide
surfactant
weed

____________________ 1. An unwanted plant, especially if it competes with desired varieties. (page 183)

____________________ 2. Any substance that, when dissolved in water, reduces the surface tension between it and another liquid. (page 189)

____________________ 3. A herbicide applied to eliminate problem weeds before planting the crop. (page 184)

____________________ 4. A tiny worm-like organism which is sometimes parasitic on plants. (page 171)

____________________ 5. A pesticide which kills weeds or other plants. (pages 183-184)

____________________ 6. The study of insects. (page 152)

____________________ 7. A pesticide which kills weeds or other plants upon contact. (page 184)

____________________ 8. To determine, check or change the graduation of a sprayer. (page 189)

____________________ 9. A compatibility agent used to prevent two pesticides from separating when combined in a sprayer. (page 190)

____________________ 10. Controlling pests without the use of chemicals. (page 164)

____________________ 11. The study of plant diseases. (page 174)

____________________ 12. Not in active growing condition. (pages 154-155)

____________________ 13. The larval stage of some insects. (page 152)

____________________ 14. A "fungus form" organism responsible for certain plant diseases. (page 171)

____________________ 15. The young of an insect that undergoes incomplete metamorphosis. (page 154)

NAME ____________________

TERMS TO REMEMBER - Chapter 7

PART 2

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 7 of *The Nursery Worker*.

Technical Vocabulary

- bacteria
- band application
- broadcast application
- cambium
- compatibility agent
- necrosis
- pasteurize
- pupa
- quarantine
- rodenticide
- selective herbicide
- systemic poison
- translocated herbicide
- viable
- viruses

____________________ 1. An adjuvant used to prevent two pesticides from separating in a sprayer. (page 190)

____________________ 2. Isolation to prevent the spread of infection. (page 174)

____________________ 3. Minute organisms frequently causing disease. (page 167)

____________________ 4. Infective agents which can cause disease. (page 171)

____________________ 5. The layer of tissue between the inner bark (phloem) and the wood (xylem) that produces all secondary growth in plants. (page 178)

____________________ 6. The death of plant cells in a living plant. (glossary)

____________________ 7. Capable of germination or growth. (glossary)

____________________ 8. Herbicide which moves within the plant and kills all parts of it. (page 184)

____________________ 9. A poison which is absorbed directly into the plant and translocated to plant parts above the ground. (page 192)

____________________ 10. Application of pesticide in bands along rows of plants. (page 185)

____________________ 11. A herbicide which will kill certain plants with little or no damage to others. (page 184)

____________________ 12. A pesticide that kills rodents. (page 192)

____________________ 13. An insect in a nonfeeding, usually immobile, transformation stage. (page 154)

____________________ 14. To expose to a high temperature in order to destroy certain microorganisms. (page 191)

____________________ 15. Application of a pesticide or fertilizer spread randomly over the field. (glossary)

NAME ______________________

TERMS TO REMEMBER - Chapter 7

PART 3

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 7 of *The Nursery Worker.*

Technical Vocabulary

chlorosis
contact poison
defoliation
emulsifiable concentrate
fumigant
fungi
gall

girdle
larva
metamorphosis
mycelium
nonselective herbicide
parasite

______________________ 1. Yellowing of leaves due to a lack of chlorophyll development. (page 171)

______________________ 2. An abnormal growth of plant tissue around eggs or larvae of an insect parasite. (page 160)

______________________ 3. A condensed formulation usually diluted with water or oil before use. (page 189)

______________________ 4. The immature, wingless feeding stage of certain insects. (page 154)

______________________ 5. A pest or organism that lives upon another organism. (page 169)

______________________ 6. The process of losing leaves. (glossary)

______________________ 7. Microscopic plant organisms responsible for certain plant diseases. (page 169)

______________________ 8. A gaseous chemical used to kill pests. (page 191)

______________________ 9. A poison which kills upon contact. (pages 184, 192)

______________________ 10. To remove a strip of bark from around a tree trunk or branch. (page 178)

______________________ 11. The structural or functional change of a living organism during its development. (page 153)

______________________ 12. The fine threadlike growth of a fungus. (page 169)

______________________ 13. The pesticide which destroys or prevents growth of plant life in general without regard to species. (page 184)

NAME ______________________

LETTER MAZE 7

The 30 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
X J R Z O P J N A Q I O T P A Y X Q O F Q D T R E N Z T F V Q D
C P C T V L W V I Y M O X V V S X E Y P N O V G A L L J E N E A
N K A J G J R B J V E B Q W R C T F B T S R J I T X D R W V P E
B X L U O A U X V R T G U Z J I X J J Q M M J K R U K V K A O Q
U O I Q L R J W B A A S D O S A W K M P P A I A D U J B V K C O
G Q B G G J F Q Z U M J E A C S D U C Q M N C M K C S D E F Q T
T Y R H N A W Z X K O X R B L W D J B A C T E R I A T E V N N R
Q H A T O N B O J H R A Z W F R E O U V R J D M M N P V M V Z K
E F T W B Y H B F F P D S F B H F Z E V A B E Z A Q H Q E L S H
C E E K D I M H L P H N H C F M O I G K A T M T W X D D L H Z W
J Z M N T E O I X U O C Y P U C L M O Q S N C Y K V I A B L E V
W X S B C P U X Y T S E H I O Z I B Y Y U A T L H C N U U N X F
H N U P H Z Z B L D I P B L S X A G S C F A E D I D Y A O E Y X
F G F Q V E U M H S S M R J O P T P N R O I R T U V M J I R Q L
S G W J U F O E C F A U Q B M R I Z U G T P N A X V P T E D U C
E D D L H E G G E C M H V J I A O S O U C E L S N Z H W L M Y C
G Z Q Q R P O E N Q Y N Q D L D N S I G D Q S A Y T G F T W B B
F J W Y M I C E E S C Q Q E A D E A I O K I Z E S D I Q S E F Y
J F C S Y X E D M F E N G Y J Z C Z R S C C S W M M H N J G P O
F L W J C N H B A V L C E U Y U M B C Q L M G F I Q A J E N V Y
S Q X S Q T I N T W I U P C Z F B N N C K P X Z K C N X M J N E
K Q U C L F V R O R U P A D R S C B B O T M T Q S E U K S F N Z
M L S G Q H U U D Q M T Y M T O Z O T A X Q D F H D I A J Q C I
A B V S K E D M E K Y Q F Z M L S B R V U J C L K T U J I S V Q
F U N G I R F X I D G S B T M J Z I I V J P P A S T E U R I Z E
V S D D O B D P I G F Y D K V R B O S F B W Q K V C D J Z X G A
D Y Q K U I A H U M A B K W J W T E Z S D C O H Q E K P K Z G Z
G L P J C C P H F Z K N R B C P E O D G E E C I E Y Q D Q Q S R
O V A X H I O U H H L R T E N T O M O L O G Y W X U Q Y M B S K
M P C Q T D V V P F A W C L E A X Z W Y G J U C B D R D P B O I
T A F A P E Z Z S A T C W C J C S N Z M X H H J Y U I F L Q R A
```

ADJUVANT
BACTERIA
CALIBRATE
CAMBIUM
CHLOROSIS
DEFOLIATION
DORMANT
ENTOMOLOGY
FUMIGANT
FUNGI
GALL
GRUB
HERBICIDE
LARVA
METAMORPHOSIS
MYCELIUM
MYCOPLASMA
NECROSIS
NEMATODE
NYMPH
PARASITE
PASTEURIZE
PUPA
QUARANTINE
RODENTICIDE
SURFACTANT
SYSTEMIC
VIABLE
VIRUS
WEED

Crossword Puzzle 7 - Clues

ACROSS Clues

1. Treatment made *after* the crop is planted but *before* it emerges from the ground. (page 184)
6. The study of insects. (page 152)
7. Threadlike filaments formed by fungi. (page 169)
9. A ________ variety is tolerant of adverse conditions. (page 167)
11. A ________ herbicide destroys all plants with which it comes in contact. (page 184)
14. A thick, wormlike larva of a beetle. (page 152)
17. An organism that lives on or within another organism (host). (page 169)
19. Capable of germination or growth. (glossary)
21. ________ control is one method of controlling pests without the use of pesticides. (page 164)
22. Adjust a sprayer. (page 189)
23. Removal of leaves. (glossary)

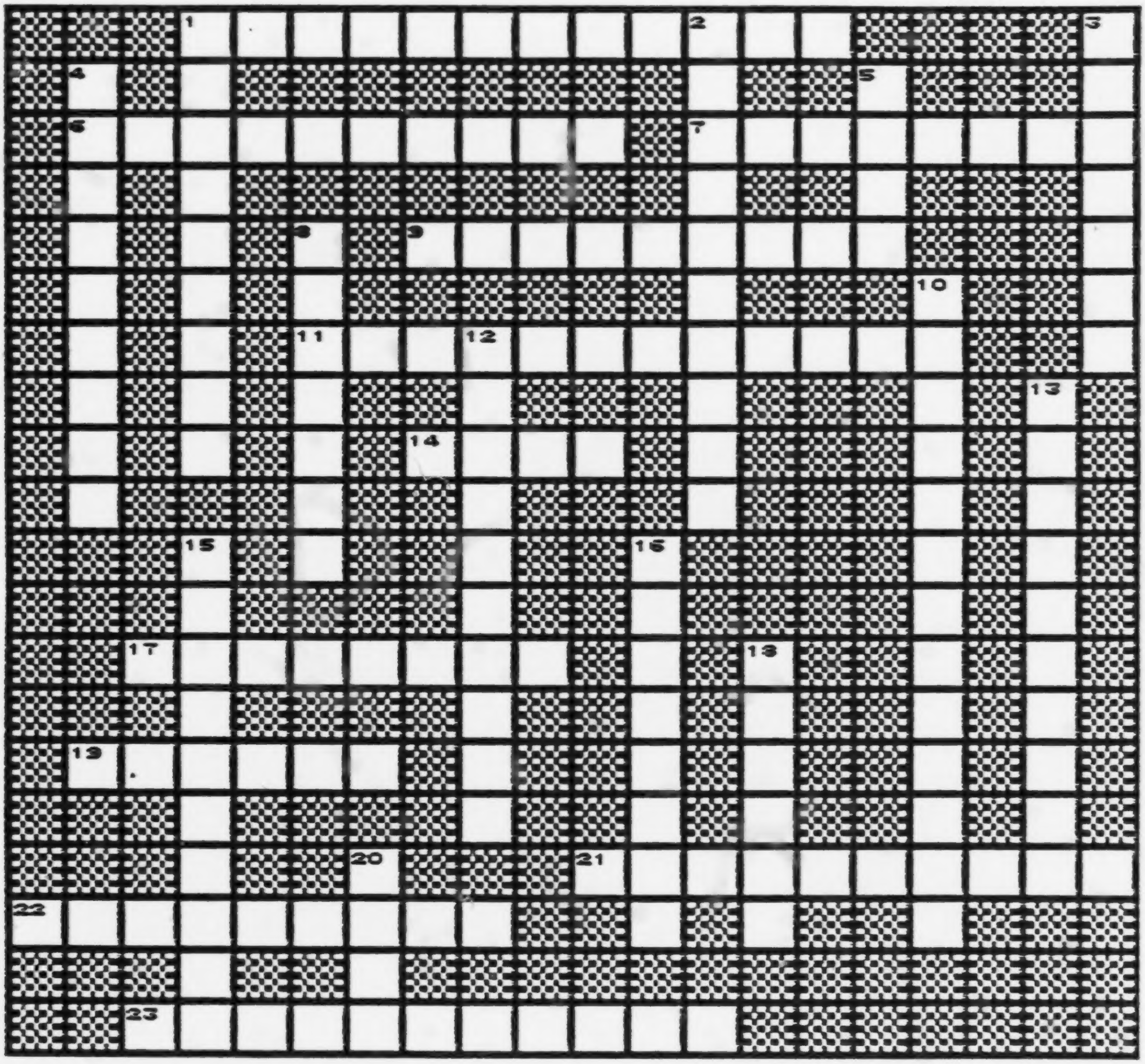
DOWN Clues

1. Plant ________ is the study of plant diseases. (page 174)
2. A chemical which kills nematodes. (page 192)
3. The layer of actively dividing cells in woody plants. (page 178)
4. A chemical which kills pests. (page 191)
5. An unwanted or harmful organism. (page 151)
8. A ________ herbicide kills all parts of a plant that it touches. (page 184)
10. A change in form or structure as in insects. (page 153)
12. A material added to pesticides to make them spread or disperse more effectively. (page 189)
13. The plant pest which causes diseases such as aster yellows. (page 171)
15. Isolation to prevent the spread of pests or disease. (page 174)
16. The death of plant cells. (glossary)
18. To remove a strip of bark from a trunk or branch resulting in plant death. (page 178)
20. An abnormal growth of plant tissue. (page 160)

NAME ____________________

CROSSWORD PUZZLE 7

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in *The Nursery Worker.*


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23

NAME ____________________

STUDENT EXERCISE 7-A

USING REFERENCES ON INSECTS

The aim of this exercise is to familiarize students with references on insects.

MATERIALS:

- any insect reference books found in the school library or on the nursery reference shelf.

PROCEDURE:

Select three insects from the list of insects found in Ohio nurseries (*Student Manual*, Table 7-1, pages 157-159). From the references obtain the information to fill in the blanks below. You may reword the reference to make your report brief but meaningful.

1. a. **Name of Insect** ____________________
   b. Description of insect ____________________
   c. Type of damage done to host ____________________
   d. Life cycle ____________________
   e. Damaging stage ____________________
   f. Overwintering stage ____________________
   g. Any unique qualities pertaining to the insect ____________________

2. a. **Name of Insect** ____________________
   b. Description of insect ____________________
   c. Type of damage done to host ____________________
   d. Life cycle ____________________
   e. Damaging stage ____________________
   f. Overwintering stage ____________________
   g. Any unique qualities pertaining to the insect ____________________

(continued)

Student Exercise 7-A *(continued)*

3. a. **Name of insect** ______________________________

b. Description of insect ______________________________

____

c. Type of damage done to host ______________________________

____

d. Life cycle ______________________________

____

____

e. Damaging stage ______________________________

f. Overwintering stage ______________________________

g. Any unique qualities pertaining to the insect ______________________________

____

EVALUATION:

The exercise was completed accurately. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 7-B

USING REFERENCES ON PEST CONTROL

Using appropriate literature, students will be able to determine recommendations for controlling pests.

MATERIALS:

- copy of Ohio Cooperative Extension Bulletin 504 or
- similar references listing specific control measures for nursery pests

PROCEDURE:

Complete the following chart by looking up the recommendations for the pest found on the host indicated. Select only two pesticides for each pest if more than one is recommended.

Host	Pest	Recommended Pesticide	Formulation	Amount to Add to 100 Gal. Water	When to Treat
Yew	Fletcher scale	1.			
		2.			
Juniper	Bagworm	1.			
		2.			
Birch	Birch leaf miner	1.			
		2.			
Pine	Pine bark aphid	1.			
		2.			
Azalea	Black vine weevil	1.			
		2.			

EVALUATION:

The chart was completed accurately. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 7-C

USING REFERENCES ON DISEASE CONTROL IN PLANTS

Using appropriate literature, students will be able to determine recommendations for controlling plant diseases.

MATERIALS:

- plant disease references
- bulletins from your state's Cooperative Extension Service

PROCEDURE:

Choose 3 plant diseases from the list on page 173 of *The Nursery Worker*. Complete the chart below by looking up the topics listed for each disease. Use a maximum of two recommendations for control.

PLANT DISEASES

Disease	Symptoms	Recommended Control

EVALUATION:

The chart was completed accurately. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 7-D

IDENTIFYING INSECTS AND RELATED PESTS IN THE NURSERY

Insects and related pests destroy the quality of nursery crops. Unfortunately, no nursery is totally free of these pests. Nursery employees are often faced with the job of controlling pests. However, treatment can never be suggested until the pest is identified. Therefore, you should be able to identify these insects and related pests.

MATERIALS:

- references - books and/or extension publications
- access to the nursery area
- 12-inch ruler
- sharp #2 pencil with eraser
- student notebook

PROCEDURE:

1. Go into the nursery with your notebook, pencil, and this exercise. List all the major crops currently being grown there. (*Examples*: taxus, juniper, maple, etc.) List these plants in the following blanks.

   (1) ____________________

   (2) ____________________

   (3) ____________________

   (4) ____________________

   (5) ____________________

   (6) ____________________

2. Return to the classroom after you have identified and listed the major crops.

3. For each major crop being grown in the nursery, use your references to identify the insects and similar pests which commonly attack the crop. Record this information by constructing a chart (Figure 7-1) for each major crop you listed.

4. Next, describe the visible plant symptoms associated with each type of pest. Record this information on your chart.

Example:

CROP Euonymus

Pest scale

Visible Plant Symptoms small scab-like lumps on twigs

Pest bagworms

Visible Plant Symptoms sacklike structures hanging from branches

Figure 7-1. Sample plant symptom chart

(continued)

Student Exercise 7-D *(continued)*

EVALUATION:

1. All major crops grown in the nursery were listed. ______________
2. The common insects and similar pests associated with each crop were listed. ______________
3. The plant symptoms associated with each insect or pest were listed. ______________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 7-E

IDENTIFYING DISEASE PROBLEMS IN THE NURSERY

Good management and sanitation are essential for controlling plant disease in the nursery. However, weather conditions or a combination of environmental conditions can result in disease problems. Your ability to recognize diseases and react quickly will increase the chances of crop survival. Therefore, you should be able to identify common diseases and plant symptoms associated with them.

MATERIALS:

- references on plant disease
- access to the nursery growing area
- 12-inch ruler
- sharp #2 pencil with eraser
- student notebook

PROCEDURE:

1. Go into the nursery with your notebook, pencil, and this exercise. Identify all the major crops currently being grown there. List these crops in the spaces below.

   (1) ____________________

   (2) ____________________

   (3) ____________________

   (4) ____________________

   (5) ____________________

   (6) ____________________

2. For each major crop being grown in the nursery, use the references to:

   A. Identify the diseases which commonly attack these crops (whether or not they are present in the nursery).

   B. List the visible plant symptoms associated with each type of disease. Record your information in a chart like that in Figure 7-2. Make sure there is room on your chart for each major crop you have listed. Remember, list the diseases described in the references. The plants in our nursery may be completely disease-free.

CROP ____________________

Disease ____________________

Visible Plant Symptoms ____________________

____

Disease ____________________

Visible Plant Symptoms ____________________

____

Figure 7-2. Sample plant symptom chart

(continued)

Student Exercise 7-E *(continued)*

3. Using references, record your answers to these questions in the blanks provided.

   A. What is a plant disease? ______________________________

   ____

   B. Name three living organisms which can cause plant disease. ______________________________

   ____

   C. List three environmental factors (or conditions) which may lead to disease problems in the nursery.

   ____

   ____

   ____

   D. Why is sanitation an important part of disease control?

   ____

   ____

   ____

EVALUATION:

1. All major crops grown in the nursery were listed. ____________
2. Common disease problems associated with each crop were listed. ____________
3. Plant symptoms associated with each disease problem were listed. ____________
4. All requested information was supplied neatly and accurately. ____________

FINAL GRADE ________

NAME ______________________

STUDENT EXERCISE 7-F

READING PESTICIDE LABELS

To control pests (insects, disease, weeds, etc.) you must first be able to read and follow instructions on pesticide labels. Labels state how pesticides should or should not be used. Labels also give directions for applying pesticides safely. Both you and your crops can be harmed if label information and directions are not read **carefully.**

MATERIALS:

- references on pest control
- sharp #2 pencil with eraser

PROCEDURE:

Read the labels provided on pages 7-26 to 7-28.

1. Answer the following questions using the Isotox® label.
   A. What types of pests does this pesticide control?
   B. When the label includes "Japanese beetle," to what stage of the insect's life cycle is it referring?
2. Answer the following questions using the Funginex® label.
   A. What type of pests does this pesticide control?
   B. What crops can legally be treated with this pesticide?

(continued)

Student Exercise 7-F *(continued)*

3. Answer the following questions using the Weed-B-Gon® label.

   A. What type of pests does this pesticide control?

   ____

   ____

   ____

   ____

   B. Is it used to control grasses or broadleaf weeds?

   ____

   C. Does it control annuals, biennials, or perennials?

   ____

- - - - - - - - - - - - - - - - - - - -

Note: Trade names are used for identification only. No product endorsement is implied nor is discrimination intended by the Curriculum Materials Service.

EVALUATION:

All questions were answered accurately. ____________

FINAL GRADE ________

(continued)

Student Exercise 7-F *(continued)*

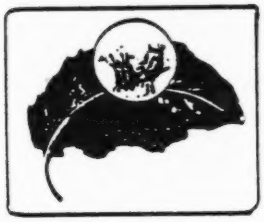
Chevron

ORTHO ISOTOX® Insect Killer

Makes Up To
32 Gallons Spray

ORTHO
ISOTOX
Insect Killer

CONTROLS: Aphids, Mites, Thrips, Mealybugs, Whiteflies, Scales and many other listed pests on Roses, Flowers, Ornamentals, Shrubs and Trees



CONTAINS ORTHENE SYSTEMIC INSECTICIDE AND KELTHANE MITICIDE

ALSO CONTROLS JAPANESE BEETLES

Active Ingredients	By Wt.
*Acephate (O,S-Dimethyl acetylphosphoramidothioate)	8.0%
**1,1-bis (p-chlorophenyl)-2,2,2-trichloroethanol	3.0%
Inert Ingredients	89.0%

*ORTHENE, U.S. Pat. No. 3,716,600
**KELTHANE, T.M. Reg. U.S. Pat. Off. by Rohm & Haas Co.

Keep out of reach of children

WARNING

See side panel for additional precautionary statements.

NET CONTENTS 1 QT.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

WARNING: Causes eye irritation. Do not get in eyes. Avoid contact with skin or clothing. Harmful if swallowed. Avoid breathing vapor or spray mist. Wash thoroughly after handling. In case of eye contact, immediately flush eyes with fresh water for 15 minutes and get medical attention. If swallowed, promptly drink a large quantity of water and induce vomiting. Get medical attention immediately. *Note to Physicians:* Emergency information — call (415) 233-3737. This product contains a cholinesterase inhibitor. If signs and symptoms of cholinesterase inhibition are present, atropine is antidotal. 2-PAM may also be given in conjunction with atropine.
ENVIRONMENTAL HAZARDS: This pesticide is toxic to fish. Use with care when applying in areas adjacent to any body of water. Keep out of lakes, ponds and streams. Do not apply when weather conditions favor runoff or drift from treated area. Do not contaminate water by cleaning of equipment or disposal of wastes. **PHYSICAL OR CHEMICAL HAZARDS:** Flammable. Keep away from heat and open flame.

Chevron Chemical Company
Ortho Consumer Products Division
San Francisco CA 94120-7144
Richmond CA 94804-0036
Product 5442   Made in U.S.A.
Form 10096-0
EPA Reg. No. 239-2470-AA
Ⓢ Ⓓ Ⓟ
EPA Est. 239-CA-1, 239-NJ-1 239-MO-1
Superscript used is first letter of lot number

DIRECTIONS FOR USE: It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH LABEL PRECAUTIONARY STATEMENTS AND DIRECTIONS.

HOW TO USE: Mix thoroughly and spray entire plant, covering both upper and lower leaf surfaces. May be applied with an ORTHO SPRAYETTE, ORTHO Lawn and Garden Sprayer, tank-type or power sprayer. Make new dilution for each use. This product is designed for outdoor use only by home gardeners. It has not been tested on rare unusual varieties; therefore, when these plants are present, it is advisable to test on a few plants before spraying large numbers. Do not apply to plants to be used for feed or food.

Rate to Apply—Aphids on Roses, Flowers, Shrubs, Trees: Apply 2 Tbs. (1 fl. oz.) to 1 gal. water. Spray as aphids appear. Repeat if reinfestation occurs.

Japanese Beetle on Roses, Linden and Boston Ivy: Apply 4 Tbs. (2 fl. oz.) in 1 gal. water. Begin spraying when beetles or their damage first appear and repeat at 7 to 10 day intervals for as long as needed.

All other Listed Pests on Roses, Flowers, Shrubs and Trees: Apply 3 Tbs. (1½ fl. oz.) to 1 gal. water. Spray when insects or mites are present or feeding damage is first noticed. Repeat if reinfestation occurs. For Mealybugs, Flower Thrips, Whiteflies, Mites, Scales and other hard-to-control pests, spray 2 to 3 times about 7 to 10 days apart. For best results, apply at first sign of infestation, before population becomes large.

CONTROLS: Ash Plant Bug, Bagworm, Beet Armyworm, Birch Leafminer, *Black Vine Weevil, Budworms, Cabbage Looper, Catalpa Sphinx Moth (larvae), Cottonwood Leaf Beetle, Cuban Laurel Thrips, Elm Leaf Beetle, Fall Cankerworm, Fall Webworm, Gypsy Moth (larvae), Holly Leafminer, Lacebugs, Leafrollers, Leafhoppers, Lilac Leafminer, Maple Shoot Moth (larvae), Mimosa Webworm, Mealybugs, Nantucket Pine Tip Moth (larvae), Oak Webworm, Obscure Root Weevil, Orangestriped Oakworm, Poplar Tentmaker, Psyllids, Saddled Prominent Caterpillar, Sawflies (Dusky Birch, Blackheaded Ash, Redheaded Pine and European Pine), Scales (crawlers), Spittlebugs, Spruce Mite, Stinkbugs, Thrips, Tent Caterpillars, Two-spotted Spider Mite, Whiteflies, Willow Leaf Beetle.

PLANTS: Ageratum, Alpine Currant, Aluminum Plant, Alyssum, Andromeda, Arborvitae, Ash, Aspen, Aster, Azalea, Bald Cypress, Birch (Gray, Columnar, Cut Leaf, White Paper), Bird's-nest Fern, Bird's-nest Sansevieria, Bird of Paradise, Boston Ivy, Bottlebrush, Burr Oak, Calendula, Camellia, Catalpa, Chestnut Oak, Cherry Laurel, Cosmos, Crapemyrtle, Cuban Laurel, Dahlia, Dracaena, Dianthus, Elm, Euonymus, False Aralia, Flowering Plum, Forsythia, Fuchsia, Gardenia, Gazania, Geranium, Green Ash, Gladiolus, Hawthorn, Holly (American, Burford, Yaupon), Honey Locust, Impatiens, Italian Cypress, Jade Plant, Juniper, Kalanchoe, Laurel, Lilac, Linden, Maple, Marigold, Mimosa, Mountain Holly, Myoporum, Oak, Ornamental Cabbage, Ornamental Pear, Oleander, Periwinkle, Petunia, Photinia, Philodendron, Pittosporum, Poinsettia, Pine, Pyracantha, Prayer Plant, Podocarpus, Poplar, Pothos, Privet, Purple Passion, Rhododendron, Rose, Salvia, Sassafras, Schefflera, Silver Maple, Snapdragon, Spider Plant, Spirea, Spruce, Stock, Strawberry Begonia, Sycamore, Viburnum, White Oak, Wild Plum, Wild Rose, Wild Black Cherry, Willow, Yaupon, Yew, Zinnia.

NOTE: Do not apply to American Elm, Flowering Crabapple, Sugar Maple, Red Maple, Cottonwood, Redbud, Begonia and Weigela as foliage injury may occur.

***SPECIAL DIRECTIONS: BLACK VINE WEEVIL** — Apply full coverage spray to foliage and soil beneath plants. Begin applications in mid-June and make 3 additional applications at 3-week intervals.

COMBINATION SPRAY WITH FUNGICIDE OR FERTILIZER ON ROSES: ISOTOX Insect Killer may be used together with PHALTAN Rose & Garden Fungicide or ORTHOCIDE Garden Fungicide or ORTHO FUNGINEX® Rose Disease Control or ORTHO Rose & Flower Food 8-12-4 (liquid) at the rates recommended on each product label. Apply fungicide on a regular schedule to control disease and add ISOTOX Insect Killer only when insect control is desired. Do not apply more than three consecutive applications of ISOTOX Insect Killer in combination with any of the above fungicides. Clean sprayer after each use by flushing with water; do not use household bleach as a cleaning agent.

STORAGE AND DISPOSAL: Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not contaminate food or foodstuffs. Do not store diluted spray. Do not reuse empty container. Wrap container and put in trash collection.

FUNGINEX® reg. TM of CELAMERCK GmbH & Co.

NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.

(continued)

BEST COPY AVAILABLE

Chevron

ORTHO

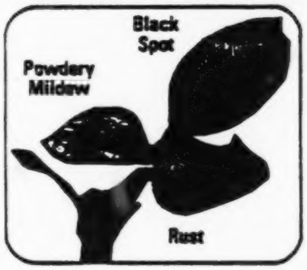
Makes 64
Gallons Spray

FUNGINEX®
Rose Disease Control

ENDORSED BY THE AMERICAN ROSE SOCIETY

ORTHO
FUNGINEX

Controls and Prevents the Three Major Diseases of Roses:



Contains Triforine Fungicide

Active Ingredient	By Wt.
Triforine(N,N'-[1,4-piperazinediylbis(2,2,2-trichloroethylidene)]bis formamide])	6.5%
Inert Ingredients	93.5%

FUNGINEX® reg. T.M. of CELAMERCK GmbH & Co.
U.S. Patent No. 3,698,108

Keep out of reach of children

DANGER

See side-panel for additional precautionary statements.

NET CONTENTS 1 QT.

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

DANGER: Corrosive to eyes. Causes eye damage. Do not get in eyes. Wear goggles or face shield when handling concentrate. Harmful if swallowed. Avoid contact with skin or clothing. Avoid breathing spray mist. In case of contact, immediately flush eyes or skin with plenty of water. For eyes, get medical attention. If swallowed, give a large amount of water to drink and induce vomiting. Get medical attention immediately. Wash thoroughly after handling. *Note to Physicians:* Emergency Information—call (415) 233-3737. **ENVIRONMENTAL HAZARDS:** Do not apply directly to water. Do not contaminate water by cleaning of equipment or disposal of wastes. **PHYSICAL OR CHEMICAL HAZARDS:** Do not use or store near heat or open flame.

Chevron Chemical Company
Ortho Consumer Products Division
San Francisco CA 94120-7144
Richmond CA 94804-0036
Product 5314   Made in U.S.A.
Form 9544-F   EPA Est. 239-MO-1
EPA Reg. No. 239-2435-AA

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH LABEL PRECAUTIONARY STATEMENTS AND DIRECTIONS.

To Open: Remove cap by squeezing sides at arrows while unscrewing.

ORTHO FUNGINEX® Rose Disease Control contains the active ingredient Triforine, an effective fungicide which will control and prevent black spot, powdery mildew and rust—the three most important diseases of roses. Used as directed, ORTHO FUNGINEX® Rose Disease Control will not harm rose flowers or foliage. This product also controls powdery mildew on calendula, crapemyrtle, dahlia, euonymus, Jerusalem thorn, lilac, phlox, photinia, snapdragons and zinnias. It also controls poplar leaf rust on poplars, aster rust on asters and carnation rust on carnations.

DIRECTIONS

For control of aster rust on asters and carnation rust on carnations, use ORTHO FUNGINEX® Rose Disease Control at the rate of 2 teaspoonfuls per gallon of water. For all other uses, use ORTHO FUNGINEX® Rose Disease Control at the rate of 1 Tablespoonful (½ fl. oz.) per gallon of water. Spray thoroughly to cover all plant surfaces (both upper and lower leaf surfaces) including new growth. For best results apply with an ORTHO SPRAY-ETTE, ORTHO Lawn and Garden sprayer or pump-up sprayer. Use mixture at once. Does not require the addition of wetting agents.

WHEN TO USE

To prevent disease, begin spraying with ORTHO FUNGINEX® Rose Disease Control when first sign of listed diseases appear in the spring. Apply every 7 to 10 days during the spring and fall. However, if weather conditions that encourage the growth and spread of the disease causing fungi occur during the summer months, it may be necessary to continue spraying throughout the growing season. **NOTE:** If infection has already occurred on the plants at time of spraying, follow a 7 day application schedule to control the fungus. Then continue on a 7 to 10 day application schedule to prevent re-establishment of the disease. Leaves on which spots have already developed will not clear up, but the unaffected leaves will be protected if a regular spray program is followed.

Combination Spray with Insecticides on Roses—ORTHO FUNGINEX® Rose Disease Control may be mixed with ISOTOX Insect Killer, or ORTHENE Insect Spray, or ORTHO Malathion 50 Insect Spray, or ORTHO Diazinon Insect Spray, or ORTHO Liquid SEVIN. Follow directions on each label for insect control. Apply these mixtures only when both an insect(s) and a disease(s) claimed on the labels are present.

STORAGE AND DISPOSAL

Avoid contamination of feed and foodstuffs. Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not store diluted spray. Do not reuse empty container. Wrap container and put in trash collection.

NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.

(continued)

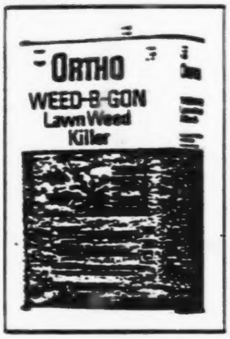
BEST COPY AVAILABLE

Student Exercise 7-F *(continued)*

Chevron

Treats 9,600 Sq. Ft.

ORTHO WEED-B-GON® Lawn Weed Killer



CONTROLS DANDELIONS WILD ONIONS PLANTAINS CHICKWEEDS HENBIT AND MANY OTHER LISTED WEEDS

Active Ingredients	By Wt.
Dimethylamine salt of 2,4-dichlorophenoxyacetic acid	10.8%
Dimethylamine salt of 2-(2-methyl-4-chlorophenoxy) propionic acid	11.6%
Inert Ingredients	77.6%

Equivalent to 9.0% 2,4-dichlorophenoxyacetic acid
Isomer specific by AOAC Method 6.001-5.
Equivalent to 9.6% MCPP 2-(2-methyl-4-chlorophenoxy) propionic acid

Keep out of reach of children

DANGER

See back panel for additional precautionary statements.

NET CONTENTS 1 QT.

Controls ANNUALS:

Black Medic
Carpetweed
Common Chickweed
Clover
Creeping Beggar Weed
Fennel
Fleabane
Florida Pusley
Wild Geranium
Hawkweed, Knotweed
Henbit
Lambsquarters
Mallow
Mouseear Chickweed
Oxalis, Pigweed
Purslane, Ragweed
Shepherdspurse
Smartweed
Sow Thistle
Speedwell, Spurge

Controls BIENNIALS & PERENNIALS:

Buckhorn Plantain
Canada Thistle
Common Burdock
Common Plantain
Curly Dock
Dandelion
Dichondra
Ground Ivy
Lawn Pennywort
Lippia
Morningglory
Oxalis
Sheep Sorrel
Thistles
Wild Carrot
Wild Garlic
Wild Onion
Yarrow

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS & DOMESTIC ANIMALS

DANGER: Corrosive to eyes. Causes eye damage. Do not get in eyes. Wear goggles or face shield when handling concentrate. Harmful if swallowed. Avoid contact with skin or clothing. Avoid breathing vapors or spray mist. In case of eye contact, immediately flush eyes with fresh water for 15 minutes and get medical attention. If swallowed, promptly drink a large quantity of water and induce vomiting. Get medical attention immediately. In case of skin contact, wash skin with plenty of soap and water. Get medical attention if irritation persists.
Note to Physicians: Emergency Information — call (415) 233-3737
ENVIRONMENTAL HAZARDS: This product is toxic to fish. Keep out of lakes, streams, or ponds. Do not contaminate water by cleaning of equipment or disposal of wastes.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.
READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH LABEL PRECAUTIONARY STATEMENTS AND DIRECTIONS.
WEED-B-GON Lawn Weed Killer is an amine formulation containing 2,4-D and MCPP. It is for effective control of lawn weeds and will not harm lawn grasses when used according to directions.
DIRECTIONS FOR USE ON LAWNS: For control of Dandelions, Chickweed, Plantains, Clover and the other listed weeds, apply WEED-B-GON Lawn Weed Killer any time weeds are actively growing. Weeds such as wild garlic and wild onions should be sprayed when they appear in late fall and again in early spring.
HOW TO USE: For best results, use an ORTHO garden hose sprayer. Refer to table for recommended dilution. If lawn needs watering, water thoroughly before application. **Do not water for 48 hours after application.** Spray entire lawn, wetting weeds and lawn grasses. Do not overspray. Spray when air is calm to avoid spray drift that might injure desirable ornamental plants. Do not apply when temperatures are expected to exceed 85° F within 24 hours following application. Make new dilution for each use.
NEWLY SEEDED LAWNS may be treated after they have been mowed at least 3 times. **BENT, BERMUDA, RED FESCUE, CENTIPEDE AND CARPET GRASSES:** Use one-half recommended rate (2 teaspoonfuls per gal. water). Temporary injury may occur. Make 2 applications 10 days apart. Do not apply to Dichondra, Lippia, St. Augustine and Clover lawns.
HARDY WEEDS: For hardy weeds such as Sheep Sorrel, Dock, Thistle and Morningglory in lawns and other areas, repeat application in 2 to 3 weeks if necessary.
IMPORTANT: Do not use this product for controlling weeds in flower or vegetable beds or around shrubs or ornamental plantings. Do not reseed for 3 to 4 weeks after use.

Dilution Table

Area To Treat	Water To Use	Amount of WEED-B-GON Lawn Weed Killer To Use***
200 sq. ft.	1 gallon	4 teaspoonfuls
1200 sq. ft.	5 gallons	8 Tablespoonfuls (4 oz.)

***Use one-half of this rate for Bent, Bermuda, Red Fescue, Centipede and Carpet Grasses.

Avoid spray contact or drift to susceptible plants as this product may injure flowers, shrubs, garden vegetables, fruit trees and other crops. Coarse sprays are less likely to drift. When ORTHO Sprayer is used and rinsed thoroughly as directed on sprayer jar **immediately after applying WEED-B-GON Lawn Weed Killer** it can be used to apply insecticides, fungicides and liquid fertilizers to ornamental plants.

TO PREPARE REFILL FOR WEED-B-GON WEED KILLER, EPA REG. NO. 239-2499: Measure [illegible] teaspoonfuls of WEED-B-GON Lawn Weed Killer into the empty container of WEED-B-GON WEED KILLER and then fill to the 20 oz. mark with tap water. Use according to the directions and precautions on the applicator bottle.

STORAGE AND DISPOSAL

Keep pesticide in original container. Do not put concentrate or dilute into food or drink containers. Do not store near feed, foodstuffs, fertilizers, seeds, insecticides or fungicides. Do not store diluted spray. Do not reuse empty container. Wrap container and put in trash collection.

NOTICE: Buyer assumes all responsibility for safety and use not in accordance with directions.

Chevron Chemical Company
Ortho Consumer Products Division
San Francisco CA 94120-7144
Richmond CA 94804-0036
Form 9817-D Product 5088
Made in U.S.A.
EPA Reg. No. 239-2342-AA

EPA Est. 239-CA-1 239-MO-1
Superscript used is first letter of lot number

BEST COPY AVAILABLE

NAME ____________________

QUIZ - CHAPTER 7

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. The type of mouthpart is one of the most important identifying characteristics of insects.

T F 2. All insects undergo metamorphosis.

T F 3. Burning trash piles or clumps of weeds is one method of controlling overwintering insects.

T F 4. Mealybugs cause little damage to ornamental plants.

T F 5. Leaf miner is a beneficial insect.

T F 6. Biological control is an attempt to restore the balance of nature by natural means.

T F 7. Quarantine laws have done little to help control pests.

T F 8. Crowded plants are less likely to become diseased than are widely spaced plants.

T F 9. Leaf spots and blights are typically caused by insects.

T F 10. Fungi generally reproduce by spores.

T F 11. Scab is an example of a disease caused by a virus.

T F 12. Scab is one of the most devastating diseases of ornamental crabapples.

T F 13. Plant diseases caused by mycoplasmas are called "yellows."

T F 14. Iron chlorosis is always caused by a lack of iron in the soil.

T F 15. The major damage caused by rabbits is girdling.

T F 16. The major damage caused by deer is girdling.

T F 17. One application of a herbicide at the recommended rate will **not** give season-long control of weeds.

T F 18. Selective herbicides are toxic to all plants.

T F 19. Contact herbicides kill only that part of the plant with which they come in contact.

T F 20. Fumigants kill all living things in the soil.

MULTIPLE CHOICE

Read each item and decide which choice answers the question or completes the statement. Circle the letter of the correct answer.

21. The study of insects is:

A. agronomy
B. entomology
C. plant pathology
D. biology

22. The hard protective covering of an insect's body is the:

A. exoskeleton
B. mandible
C. thorax
D. metathorax

23. Many spruce galls are caused by:

A. mealybugs
B. scale
C. aphids
D. scab

(continued)

QUIZ - page 2

24. Another name for Fletcher scale is:

    A. arborvitae soft scale
    B. spruce soft scale
    C. black vine scale
    D. cottony maple scale

25. Sawflies are responsible for the following:

    A. spruce galls
    B. soft scales
    C. birch leaf miner
    D. all of the above

26. Black vine weevil can be a serious pest of:

    A. spruce
    B. taxus
    C. birch
    D. maple

27. Spider mite infestations are generally at their worst during:

    A. hot dry weather
    B. cool damp weather
    C. mild winters
    D. warm rainy weather

28. Which of the following is a step used in controlling pests?

    A. identification
    B. prescription
    C. application
    D. all of the above

29. Which of the following plant families is highly susceptible to fireblight?

    A. taxus
    B. rose
    C. birch
    D. all of the above

30. Which of the following is **not** a control measure for fireblight?

    A. sanitation
    B. avoid heavy amounts of nitrogen fertilizer
    C. spray with a systemic insecticide
    D. remove infected shoots

31. Which of the following would **not** help control nematode infestations?

    A. resistant varieties
    B. fumigation
    C. crop rotation
    D. fungicides

32. The study of plant diseases is called:

    A. agronomy
    B. entomology
    C. plant pathology
    D. biology

33. Which of the following types of injury is/are caused by mice and rats?

    A. girdling
    B. damaged roots
    C. seed eaten
    D. all of the above

34. Another name for a surfactant is:

    A. miticide
    B. wetting agent
    C. herbicide
    D. pinching agent

35. Which of the following is **not** a recommended procedure to follow when handling and mixing pesticides?

    A. measure accurately
    B. handle and mix in an unventilated, airless area
    C. clean up spills immediately
    D. read label directions carefully

(continued)

QUIZ - page 3

36. Insects which have four distinct developmental stages are classified as having . . .

    A. no metamorphosis
    B. incomplete metamorphosis
    C. complete metamorphosis
    D. gradual metamorphosis

37. Which of the following is **not** a **major** body segment of an insect?

    A. scutellum
    B. head
    C. abdomen
    D. thorax

38. Insects should be controlled before they reach the ________ stage.

    A. dormant
    B. damaging
    C. cultural
    D. natural

39. Cleaning up trash, rotating crops, soil cultivation, and resistant varieties are examples of ________ control.

    A. biological
    B. chemical
    C. cultural
    D. natural

40. An insect's exoskeleton is responsible for . . .

    A. protecting vital organs
    B. digestion
    C. the type of mouthparts the insect has
    D. all of the above

41. Complete metamorphosis includes . . .

    A. insects with two life stages
    B. egg, larva, pupa, and adult stages
    C. egg, nymph, and adult stages
    D. silverfish and aphids

42. A herbicide that controls weeds at the seed germination stage is a ________ control.

    A. preplant
    B. preemergence
    C. postemergence
    D. adjuvant

43. Fumigants normally kill . . .

    A. all living things in the soil
    B. weeds only
    C. insects only
    D. diseases only

44. Incorrect application of herbicides can . . .

    A. cause death to nursery stock
    B. give poor weed control
    C. cause contamination of streams
    D. cause all of the above

(continued)

QUIZ - page 4

MATCHING

Match each term from Column B with the appropriate statement in Column A. Fill in each blank with the correct letter.

	Column A	Column B
______	45. any living thing	A. herbicide
______	46. unwanted organism	B. organism
______	47. pesticide used to control insects	C. miticide
______	48. pesticide used to control unwanted plants	D. pest
______	49. pesticide used to control fungi	E. euonymus
______	50. pesticide used to control mice and rats	F. pine
______	51. pesticide used to control mites	G. insecticide
______	52. common disease of crabapple	H. rodenticide
______	53. typical host of crown gall	I. scab
______	54. plant prone to *Diplodia* tip blight infections	J. fungicide

ANSWER KEY - CHAPTER 7

Key Questions, Part 1 - page 7-3

INSECTS AND RELATED PESTS

1. A pest is a plant or animal that is detrimental to man.
2. Entomology is the study of insects.
3. No, not all insects are harmful.
4. The major parts of an insect's body are:

   (1) head (eyes, antennae, palpi)
   (2) thorax (prothorax, mesothorax, metathorax)
   (3) abdomen (spiracles)
5. The mouthparts of a given insect determine the type of damage that insect may do to plants.
6. Metamorphosis, in insects, is a change in body form.
7. The life cycle indicates which stage of an insect may be destructive to crops. It also indicates the best stage in which to apply control measures.
8. Harmful insects which commonly infest nursery crops include: caterpillars, galls, webworms, weevils, moths, mites, miners, borers, cankerworms, lacebugs, scale, spittlebugs, mealybugs, bagworms, and aphids.

INSECT AND MITE CONTROL

9. A pesticide is a substance which kills or controls pests.
10. Biological control is an attempt to control pests and restore the balance of nature by natural means rather than with the use of chemicals.
11. Cultural control of pests includes cleaning up trash around growing crops and rotating different crops to prevent buildup of a particular pest. Soil cultivation and resistant varieties can also be a part of cultural control.
12. Six steps followed in screening and testing pesticides are:

    (1) preliminary screening
    (2) secondary screening
    (3) preliminary field testing
    (4) secondary field testing
    (5) large-scale field testing
    (6) marketing

Key Questions, Part 2 - page 7-5

PLANT DISEASES

1. The 7 steps in a successful control or management program for plant disease include:

   (1) Use resistant varieties.
   (2) Grow plants in open sites with good sun and air movement.
   (3) Protect plants from hot sun and drying winds.
   (4) Avoid overhead irrigation, especially late in the day.
   (5) Prune out affected areas.
   (6) Destroy badly diseased plants.
   (7) Improve vigor of plants with proper fertilization, soil pH control, drought stress control, or alleviation of soil compaction.
2. Four organisms that can cause plant disease are: bacteria, fungi, viruses, mycoplasmas, and nematodes.
3. The symptoms of fireblight on ornamentals include dead terminal shoots on new growth, which take on a characteristic crooked appearance, and cankers which ooze a milky gum.
4. The symptoms of scab on ornamental crabapples include: olive-green to sooty or smudgy spots on either leaf surface (especially on young leaves), definite black spots on older leaves, and dark lesions on fruit, which eventually become corky in appearance.

(continued)

Answers *(continued)*

5. Iron chlorosis is a yellowing of leaves on numerous plants. It is caused by many factors, but is commonly associated with a lack of iron. Adjusting the soil pH can often help control this disorder.
6. Four general types of control for plant diseases include: eradication, exclusion, protection, and resistant cultivars.

Key Questions, Part 3 - page 7-6

OTHER PESTS

1. Rabbits damage nursery crops primarily by girdling the plants. This makes plants unattractive and may actually kill them.
2. Deer damage nursery crops by eating twigs, tender branches, or the cambium layer of the bark (girdling), or by rubbing the plants with their antlers.
3. Mice and rats damage nursery crops by girdling the trunks and by damaging roots.
4. Animal pests in the nursery can be controlled by cultural measures or by use of repellents. Lethal control is occasionally used.

Key Questions, Part 4 - page 7-7

WEED CONTROL

1. A weed is any undesirable plant.
2. A selective herbicide kills certain plants with little or no damage to others. A nonselective herbicide is toxic to all plants.
3. A contact herbicide kills only that part of the plant with which it comes in contact. A translocated herbicide moves within the plant and kills all parts of it.
4. A preemergence herbicide controls weeds in the seed germination stage. A postemergence herbicide controls existing weeds.
5. A fumigant is a gas that kills all living things in the soil.
6. Six items to consider before applying a herbicide include:

   (1) Identification of the weed.
   (2) Careful reading of the herbicide label to determine weeds controlled and desirable plants which may be harmed.
   (3) Determination of the proper application rate.
   (4) Calibration of the sprayer.
   (5) Determination of the area to be sprayed.
   (6) Determination of how much herbicide will be needed.
7. Surfactants are substances (often called *wetting agents* or *spreaders*) which cause spray droplets to spread more, allowing more complete coverage of leaf surfaces. Compatibility agents or adjuvants are another type of surfactant which helps chemicals to mix more thoroughly.
8. An adjuvant is a type of surfactant. They are used to insure that chemicals mix thoroughly.
9. It is important to clean and store sprayers properly because proper maintenance will prevent clogging, rusting or freezing of the pump.

Key Questions, Part 5 - page 7-8

SAFE USE OF PESTICIDES

1. An insecticide is one type of pesticide. It kills only insects. "Pesticide" is a general term for any chemical which kills pests.

(continued)

Answers *(continued)*

2. The 9 steps to follow when handling and mixing pesticides are:
   (1) Read label directions and current recommendations carefully.
   (2) Wear suitable protective clothing and use appropriate equipment.
   (3) Open pesticide containers carefully.
   (4) Measure amounts accurately.
   (5) Handle pesticides in a well-ventilated area.
   (6) Avoid wind.
   (7) Don't mix pesticides near water supplies.
   (8) Clean up spills immediately.
   (9) Keep the phone number of the doctor handy and don't work alone when using pesticides.

3. The 11 steps to follow when applying pesticides are:
   (1) Calibrate application equipment carefully.
   (2) Apply pesticide at recommended rate.
   (3) Protect honey bees.
   (4) Minimize drift by applying on a calm day.
   (5) Do not work in the drift of spray or dusts.
   (6) Keep pesticides out of mouth, eyes, and nose.
   (7) Keep workers out of treated areas.
   (8) Clean all equipment after use.
   (9) Wash carefully after handling pesticides.
   (10) Keep accurate records of pesticide usage.
   (11) If symptoms of poisoning occur, call a doctor.

4. When disposing of surplus pesticides and containers, the 8 steps to follow are:
   (1) Neutralize the poisonous effect as directed on label.
   (2) Never drain the sprayer near a water supply.
   (3) Do not dump pesticides into the sewage system or gutter.
   (4) Do not discard pesticides or containers where contamination may occur.
   (5) Never dispose of pesticides with garbage fed to livestock.
   (6) Be cautious in burning empty pesticide containers.
   (7) Puncture or crush metal containers (except aerosol cans) and discard promptly.
   (8) Dispose of surplus or waste pesticides and pesticide containers by burying in an isolated area.

5. The 5 steps to follow when storing pesticides are:
   (1) Store in original, labeled containers.
   (2) Store in a dry, well-ventilated area away from food and animals. Protect from freezing.
   (3) Make sure storage area is secure from children and animals.
   (4) Check caps or cans frequently for leakage.
   (5) Do not store volatile weed killers and related herbicides with wettable powders, dusts, or seeds.

Terms to Remember, Part 1 - page 7-10

1. weed
2. surfactant
3. preplant herbicide
4. nematode
5. herbicide
6. entomology
7. contact herbicide
8. calibrate
9. adjuvant
10. biological control
11. plant pathology
12. dormant
13. grub
14. mycoplasma
15. nymph

Terms to Remember, Part 2 - page 7-11

1. compatibility agent
2. quarantine
3. bacteria
4. viruses
5. cambium
6. necrosis
7. viable
8. translocated herbicide
9. systemic poison
10. band application
11. selective herbicide
12. rodenticide
13. pupa
14. pasteurize
15. broadcast application

Terms to Remember, Part 3 - page 7-12

1. chlorosis
2. gall
3. emulsifiable concentrate
4. larva
5. parasite
6. defoliation
7. fungi
8. fumigant
9. contact poison
10. girdle
11. metamorphosis
12. mycelium
13. nonselective herbicide

(continued)

Answers *(continued)*

Crossword Puzzle 7 - page 7-15

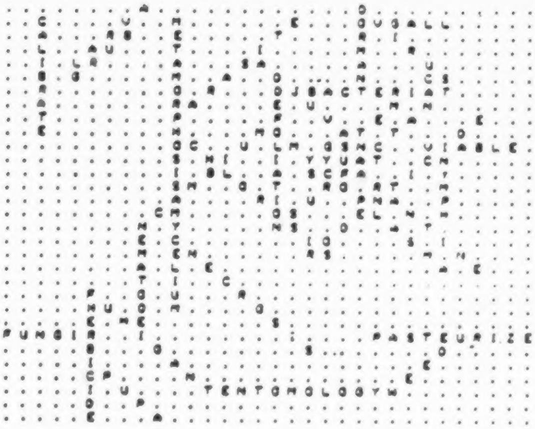
ACROSS

1. preemergence
6. entomology
7. mycelium
9. resistant
11. nonselective
14. grub
17. parasite
19. viable
21. biological
22. calibrate
23. defoliation

DOWN

1. pathology
2. nematocide
3. cambium
4. pesticide
5. pest
8. contact
10. metamorphosis
12. surfactant
13. mycoplasma
15. quarantine
16. necrosis
18. girdle
20. gall

Letter Maze 7 - page 7-13



QUIZ

True or False - page 7-29

1. true
2. false
3. true
4. false
5. false
6. true
7. false
8. false
9. false
10. true
11. false
12. true
13. true
14. true
15. true
16. false
17. true
18. false
19. true
20. true

Multiple Choice - page 7-29

21. B
22. A
23. C
24. A
25. C
26. B
27. A
28. D
29. B
30. C
31. D
32. C
33. D
34. B
35. B
36. C
37. A
38. B
39. C
40. A
41. B
42. B
43. A
44. D

Matching - page 7-32

45. B
46. D
47. G
48. A
49. J
50. H
51. C
52. I
53. E
54. F

GLOSSARY - Chapter 7

adjuvant - compatibility agent used to prevent two pesticides or a pesticide-fertilizer mixture from separating when combined in a sprayer.

bacteria - certain microscopic organisms that can cause disease in plants or animals.

band application - applying pesticides in lines or rows rather than broadcast.

biological control - an attempt to restore the balance of nature and control pests by natural means, without the use of chemicals.

broadcast application - applying pesticide over the entire area.

calibrate - to determine, check or change the graduation of any instrument giving quantitative measurements.

cambium - a layer of delicate meristematic tissue between the inner bark (phloem) and the wood (xylem) that produces all secondary growth in plants and is responsible for the annual rings in wood.

chlorosis - lack of chlorophyll development because of a nutritional problem such as lack of iron or magnesium. Can also be caused by disease.

compatibility agent - adjuvant used to prevent two pesticides or a pesticide-fertilizer mixture from separating when combined in a sprayer.

contact herbicide - a weed killer that acts primarily by touching plant tissue rather than through translocation. It usually affects only plant parts with which it comes in direct contact.

contact poison - a poison which kills upon contact.

defoliation - the process of losing leaves.

dormant - not in active growing condition. Capable of resuming growth when environmental conditions are favorable.

emulsifiable concentrate - a concentrated liquid pesticide which mixes readily with water.

entomology - the study of insects.

fumigant - a chemical used to kill insects, nematodes, fungi, bacteria, seeds, roots, rhizomes, or entire plants. Typically used within the soil.

fungi - parasitic or saprophytic plant organisms responsible for certain plant diseases.

gall - an abnormal growth of plant tissue around the eggs or larva of an insect parasite.

girdle - to remove a strip of bark from around a tree trunk or branch. This practice is sometimes used to grow larger fruits, to induce rooting, or to kill a tree.

grub - the larval stage of some insects.

herbicide - a pesticide that kills weeds.

larva - the immature, wingless, feeding stage of an insect that undergoes complete metamorphosis.

metamorphosis - the structural or functional modification of a living organism during its development.

mycelium - the fine threadlike growth of a fungus.

mycoplasma - a "fungus form" organism responsible for certain plant diseases such as aster yellows.

(continued)

Glossary *(continued)*

necrosis - the death of plant cells in a living plant. Symptoms include spots, ring, or strands of discoloration in foliage, fruits, tubers, and other tissues.

nematode - a tiny worm-like organism which is sometimes parasitic on plants.

nonselective herbicide - a pesticide which destroys or prevents the growth of plants in general without regard to species.

nymph - the young of an insect that undergoes incomplete metamorphosis.

parasite - a pest or organism that lives upon another organism.

pasteurize - expose to a high temperature in order to destroy certain microorganisms.

plant pathology - the study of plant diseases.

preplant herbicide - herbicide applied to eliminate problem weeds before planting the crop.

pupa - an insect in a nonfeeding, usually immobile, transformation stage.

quarantine - isolation to prevent the spread of infection to organisms or geographic regions.

rodenticide - a pesticide which kills rodents.

selective herbicide - a herbicide which will kill certain plants with little or no damage to others.

surfactant - any substance that, dissolved in water, reduces surface tension between it and another liquid.

systemic poison - a pesticide which is absorbed directly into the plant and translocated to plant parts above the ground.

translocated herbicide - a herbicide which moves within the plant and kills all parts of it.

transplant - the process of shifting a plant from one container or location to another.

viable - capable of germination or growth.

virus - a minute organism frequently causing disease.

weed - an unwanted plant, especially if it aggressively competes with desired plant varieties.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 7

T7-1 *(Student Manual*, page 152)

An insect body is divided into three major body parts: head, thorax and abdomen.

T7-2 *(Student Manual*, page 153)

The type of mouthpart is one of the most important identifying characteristics of insects. Knowledge of mouthparts will help you identify and control many pests.

Question: How can a knowledge of insect mouthparts help you control insects?

T7-3 *(Student Manual*, page 153)

A stink bug has piercing-sucking mouthparts. The bristles enter the host plant. The insect then draws its liquid food from the plant.

T7-4 *(Student Manual*, page 154)

Most insects undergo **metamorphosis** (a change in form) during their development. A knowledge of the life cycle of insects will help you control them.

Question: How can a knowledge of insect life cycles help you control these pests?

T7-5 *(Student Manual*, page 155)

A bagworm undergoes gradual metamorphosis. The life cycle of the bagworm is shown in this figure. The cycle is divided into two seasons — the active season and the dormant season.

Question: During which season would it be easier to control the bagworm? Why?

T7-6 *(Student Manual*, pages 155-156)

A codling moth goes through complete metamorphosis. The adult emerges in the spring and lays eggs on foliage. The larvae which develop from the eggs enter apples to feed. When mature, they enter the tree bark.

T7-7 *(Student Manual*, pages 155-156)

The three stages in this life cycle are: egg, nymph, and adult. Note that the nymph, which looks like a tiny adult, goes through several stages in its development.

T7-8 *(Student Manual*, pages 155-156)

The four stages in the life cycle of this insect are: egg, larva, pupa, and adult. The larval stage of some insects is often called a *worm* or *looper.*

Narratives for Transparency Masters *(continued)*

T7-9 *(Student Manual*, pages 164-166)

In addition to chemical control, insects and mites can be controlled through:

the use of resistant varieties
legal control
cultural control
biological control

Resistant plant varieties are crops which resist or are unharmed by pests. Legal control includes quarantine, inspection, embargo, and compulsory crop destruction. Cultural control involves planting, growing, harvesting and tillage practices which discourage pests. Biological control involves the use of natural enemies such as parasites, predators, and disease agents which are used to control pests.

T7-10 *(Student Manual*, pages 164-165)

Integrated pest control puts all the pest control methods together into a planned program to achieve pest control.

T7-11 *(Student Manual*, pages 167-173)

Symptoms of plant diseases include: decaying or rotting, abnormal growth (galls, swelling, leaf curls), underdevelopment or stunting, wilting, and discoloration.

T7-12 *(Student Manual*, page 171)

Symptoms of nematode damage are similar to plant disease symptoms (on plant parts above ground). Below the ground, nematodes cause swollen and misshapen roots and sometimes galls.

T7-13 *(Student Manual*, pages 178-180)

Field mice can cause serious economic losses to nurseries each year. Rabbits can also cause serious damage, particularly during the winter months.

Question: What is the major type of damage caused by mice and rats?

T7-14 *(Student Manual*, pages 178-180)

Girdling is the process of cutting the cambium layer (under the bark) in a ring around the plant. Girdling affects the food and water transportation system of plants.

Questions: What are the results of severe girdling? What are the results of minor girdling?

T7-15 *(Student Manual*, page 184)

Contact herbicides kill only the part of the plant they cover. Weed regrowth may occur following application of a contact herbicide.

Question: How does a translocated herbicide differ from a contact herbicide?

Narratives for Transparency Masters *(continued)*

T7-16 *(Student Manual*, pages 184-185)

Preplant herbicides are applied to eliminate problem weeds before planting the crop. **Preemergence** herbicides control weeds at the seed germination stage. **Postemergence** herbicides are applied to existing weeds.

T7-17 *(Student Manual*, page 188)

Before applying any herbicide, identify the weeds to be controlled. Then select the appropriate herbicide.

T7-18 *(Student Manual*, page 189)

Wetting agents or spreaders are terms used for **surfactants**. These chemicals cause spray droplets to spread more. This allows more complete coverage of leaf surfaces.

T7-19 *(Student Manual*, pages 191-194)

Before applying any pesticide you should read the label carefully. The label contains:

1. the name and address of the chemical company
2. the brand or trade name; the name and amount of all active ingredients
3. the type of pesticide
4. the kind of formulation
5. the EPA registration and establishment numbers
6. the storage and disposal precautions
7. a hazard statement and directions for use
8. net contents
9. the words "Keep Out of Reach of Children"
10. a signal word
11. the required time between spraying and harvest
12. the reentry interval (if applicable)
13. a general use or restricted use classification statement

T7-20 *(Student Manual*, page 192)

This is a sample label for a common miticide.

Question: What information do you need to know about this pesticide before you apply it?

T7-21 *(Student Manual*, page 192)

This is a sample label for a common fungicide.

T7-22 *(Student Manual*, pages 191-192)

Contact poisons may suffocate, paralyze, or burn the pests with which they come in contact. They are most useful for controlling insects with piercing-sucking mouthparts. Stomach poisons are used to control insects with chewing mouthparts.

Systemic poisons are absorbed directly into the plant and translocated to plant parts above ground. They kill any pest which feeds upon the plant.

Narratives for Transparency Masters *(continued)*

T7-23 *(Student Manual*, page 194)

Pesticides and pesticide containers can be disposed of by burning (depending on local regulations), burial, or recycling. You should break, crush, or cut apart the containers so they cannot be reused.

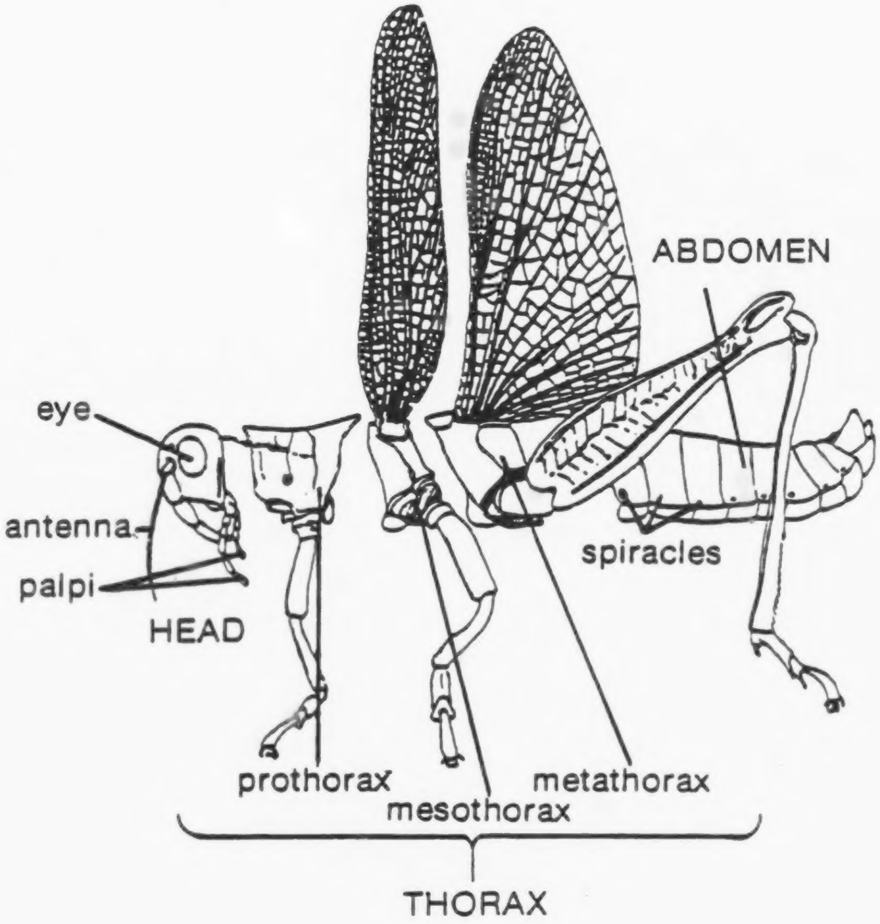
T7-24 *(Student Manual*, page 194)

The pesticide storage area should be:

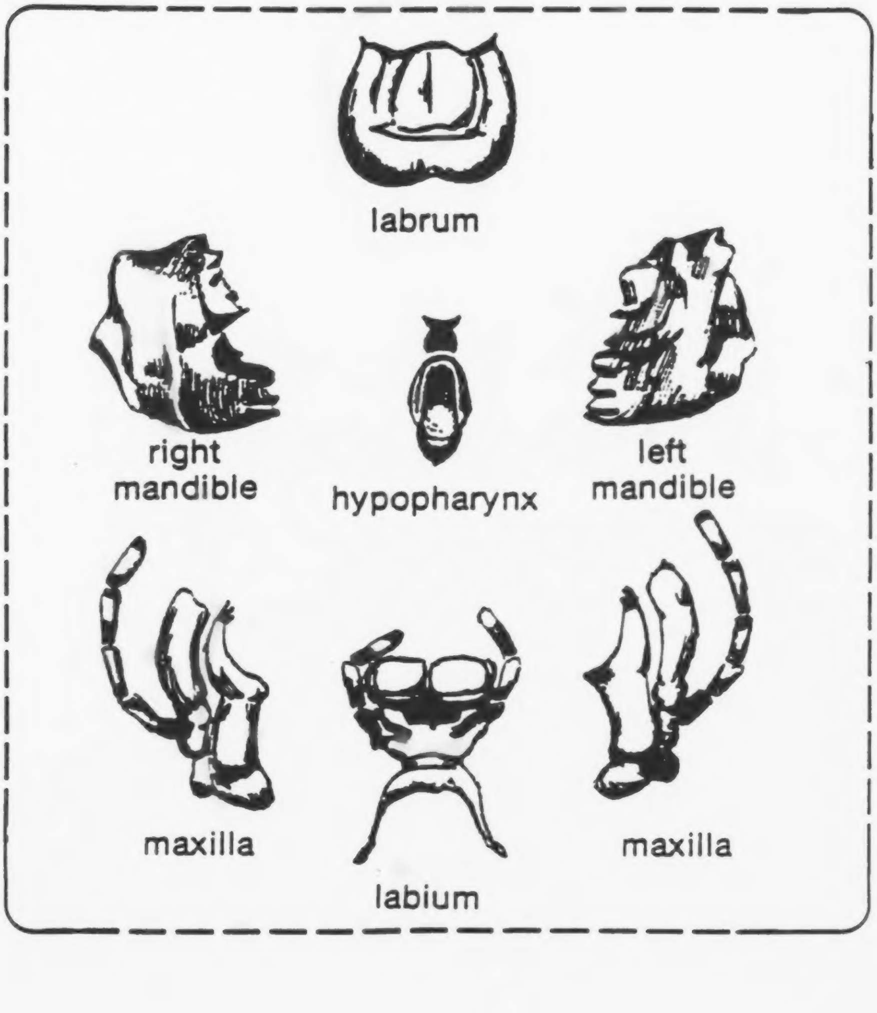
1. child-proof
2. cool, dry, and well-ventilated
3. fire-resistant
4. fenced in or locked
5. supplied with detergent, hand cleaner, and water
6. supplied with absorbent materials, such as sand, sawdust, and paper
7. supplied with shovel, broom, dust pan, and fire extinguisher.

Warning signs should be posted on the doors or windows of the area.

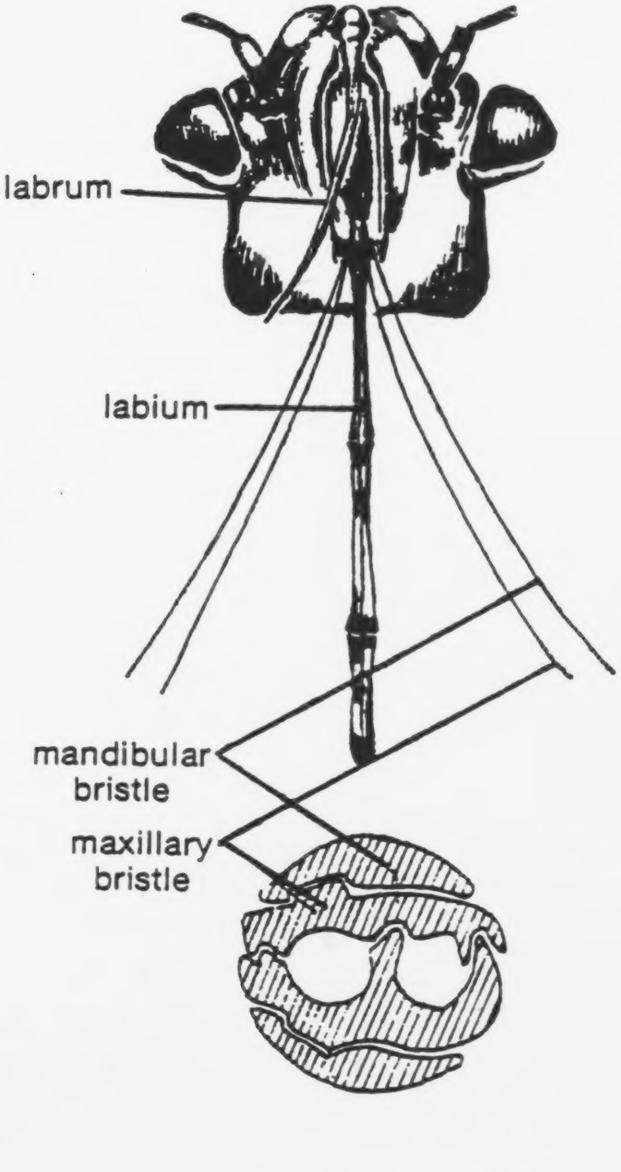
Parts of a Grasshopper


eye
antenna
palpi
HEAD
ABDOMEN
spiracles
prothorax
mesothorax
metathorax
THORAX

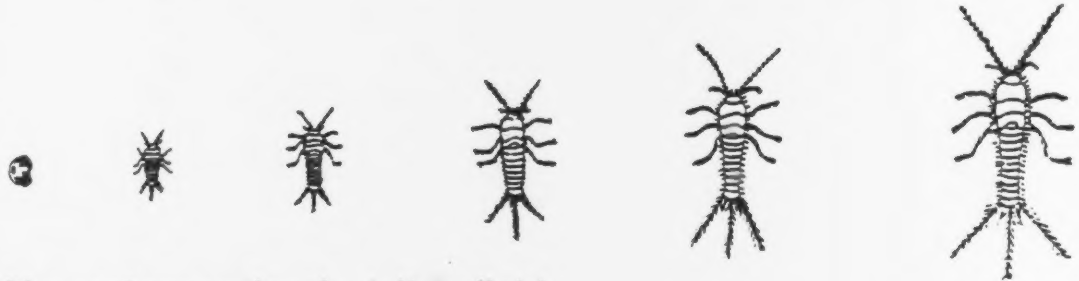
Mouthparts of a Grasshopper


labrum
right mandible
hypopharynx
left mandible
maxilla
labium
maxilla

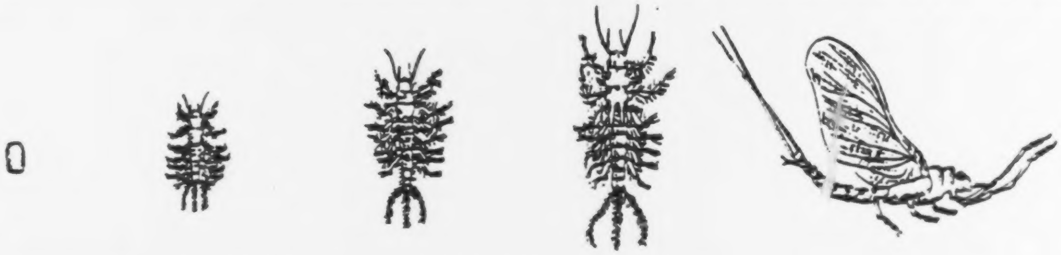
Mouthparts of a Stink Bug


labrum
labium
mandibular bristle
maxillary bristle

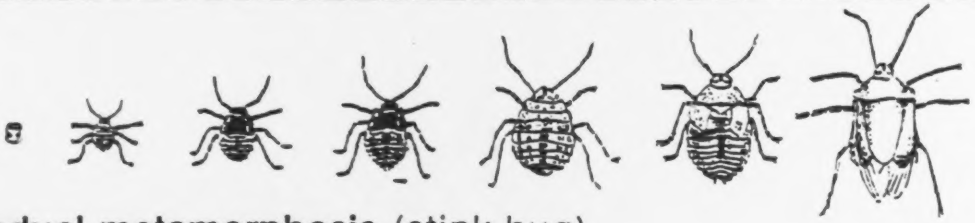
Insect Development



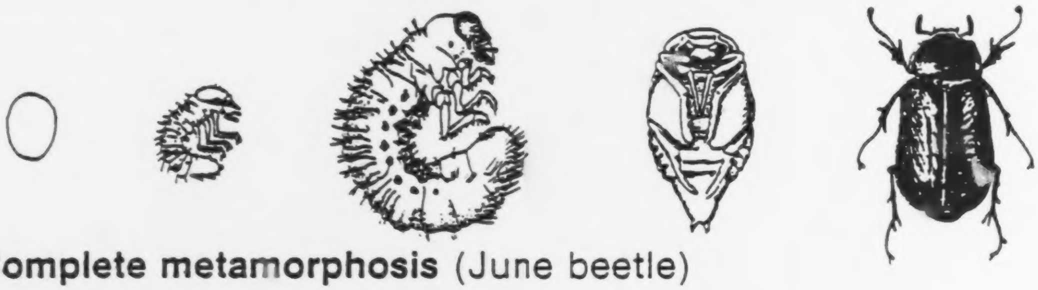
No metamorphosis (silverfish)



Incomplete metamorphosis (mayflies)

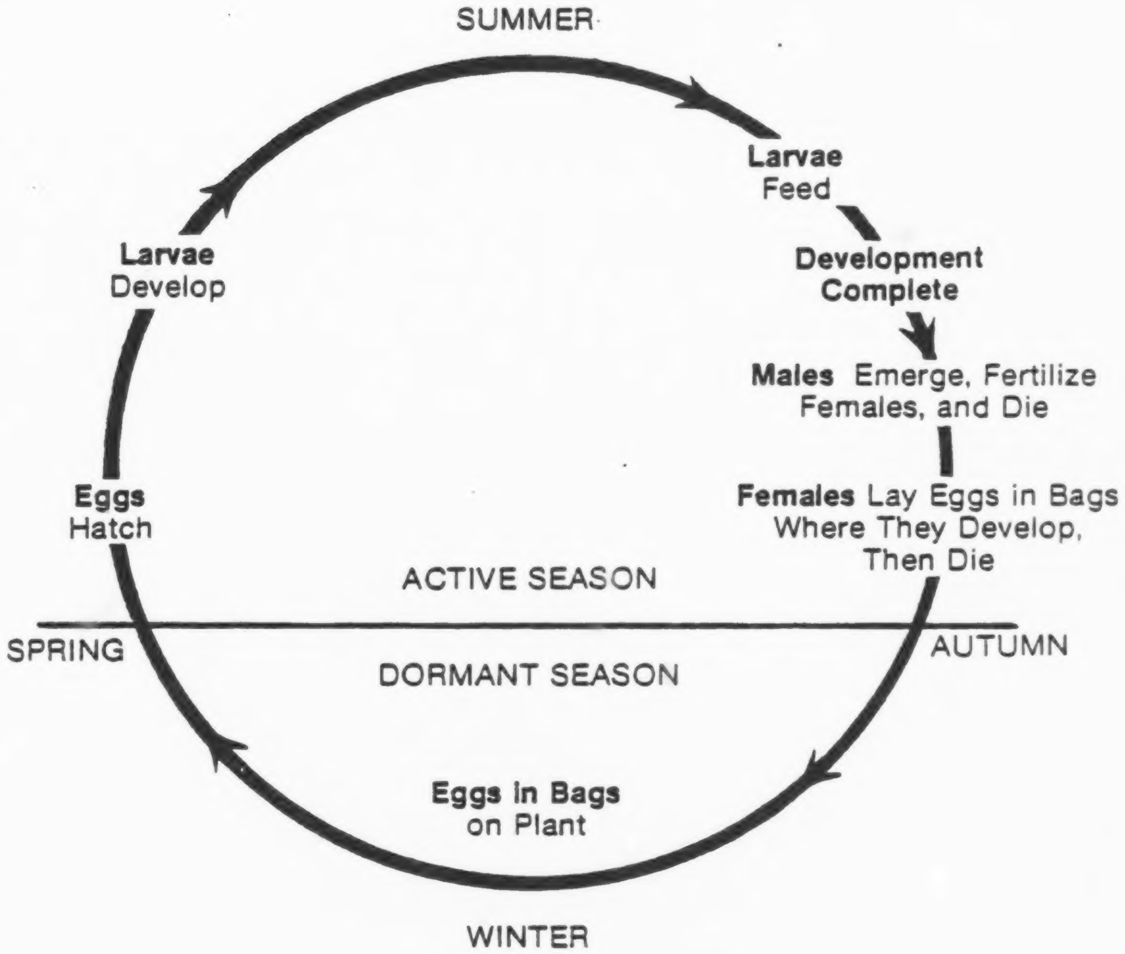


Gradual metamorphosis (stink bug)

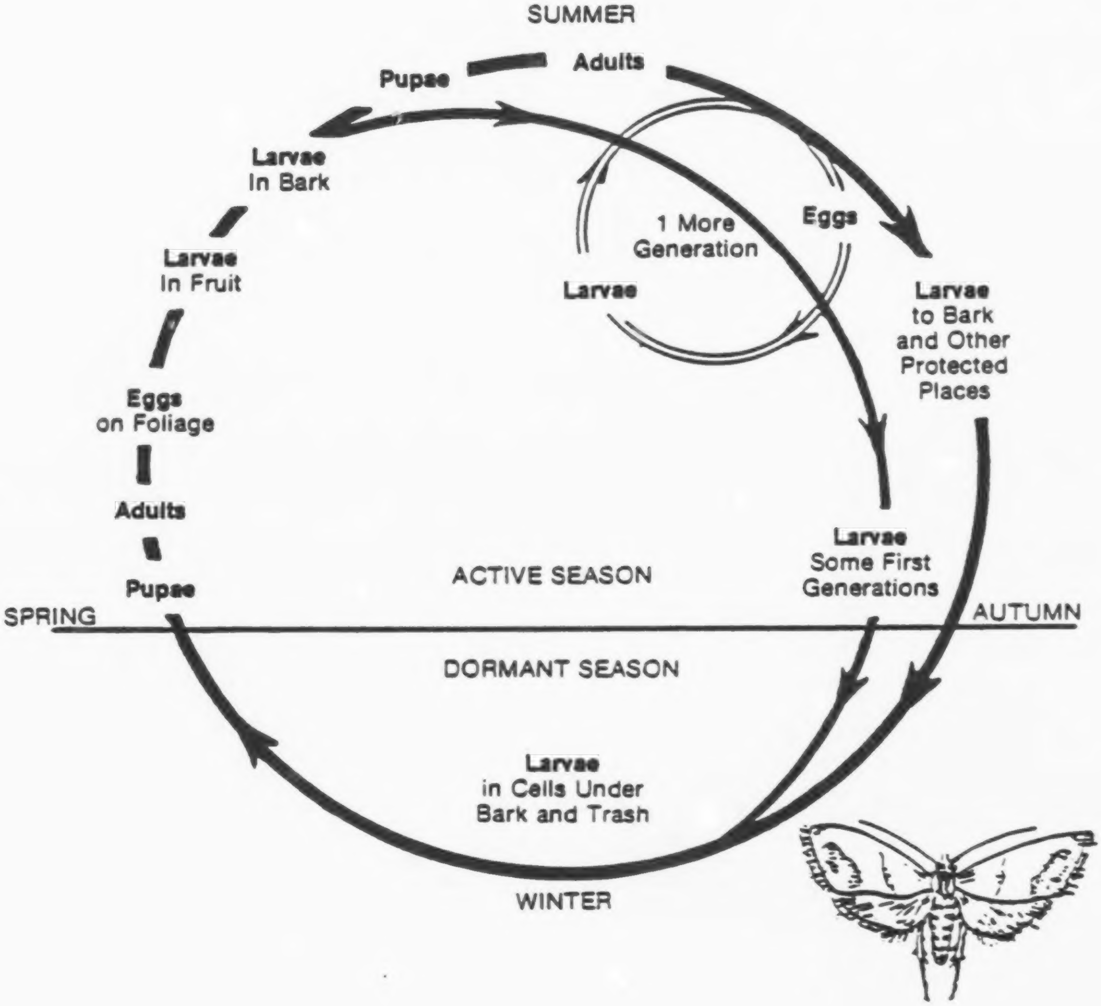


Complete metamorphosis (June beetle)

Seasonal Life History of the Bagworm

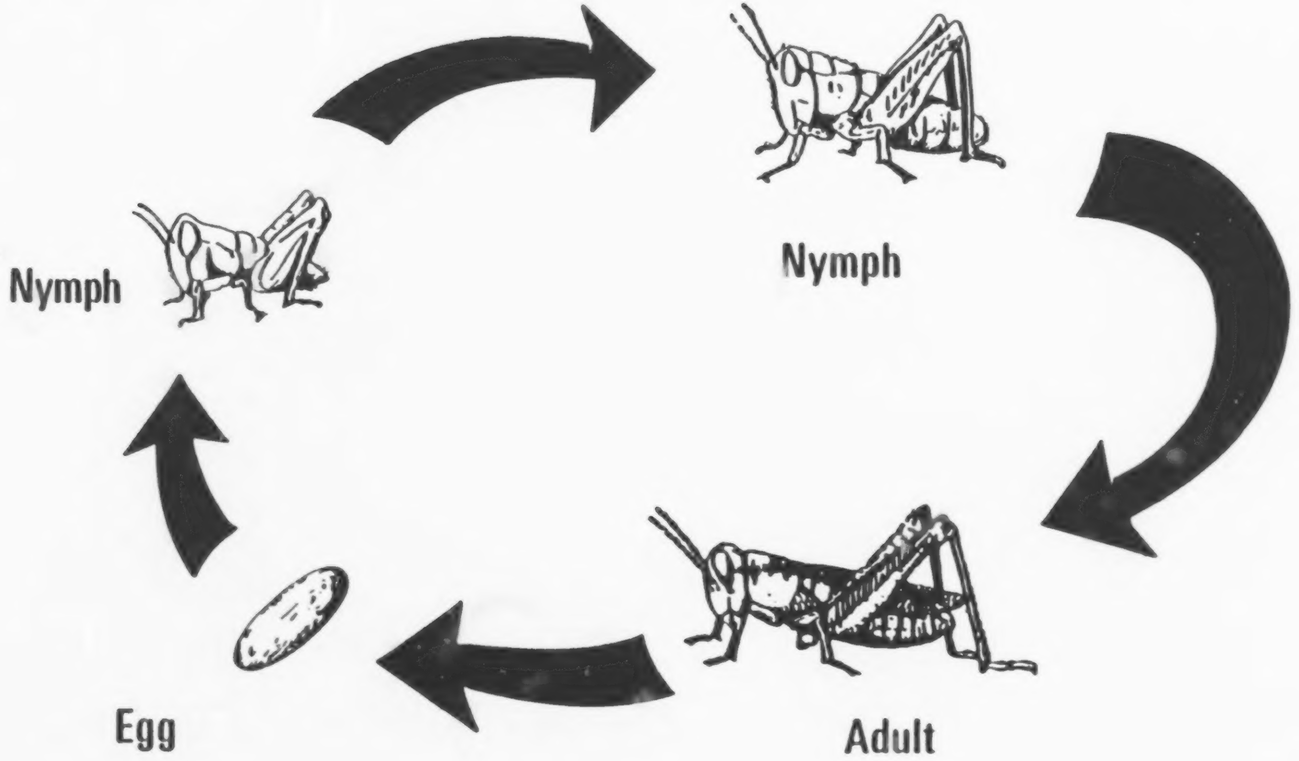

SUMMER
Larvae Feed
Development Complete
Males Emerge, Fertilize Females, and Die
Females Lay Eggs in Bags Where They Develop, Then Die
AUTUMN
ACTIVE SEASON
DORMANT SEASON
Eggs in Bags on Plant
WINTER
SPRING
Eggs Hatch
Larvae Develop

Seasonal Life History of the Codling Moth


SUMMER
Pupae
Adults
Larvae
In Bark
1 More
Generation
Eggs
Larvae
In Fruit
Larvae
Larvae
to Bark
and Other
Protected
Places
Eggs
on Foliage
Adults
Larvae
Some First
Generations
Pupae
ACTIVE SEASON
SPRING
AUTUMN
DORMANT SEASON
Larvae
in Cells Under
Bark and Trash
WINTER

376

Three Stage Life Cycle

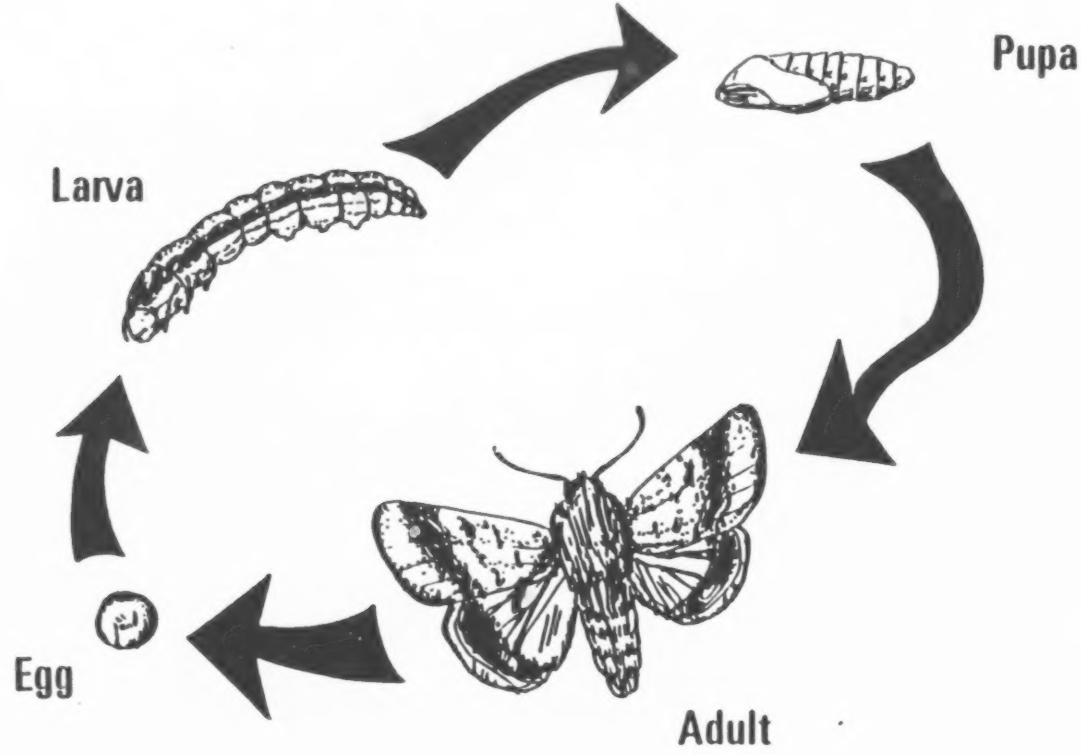

Nymph
Nymph
Adult
Egg

7-49

U.S.E.P.A.

TT-7

Four Stage Life Cycle

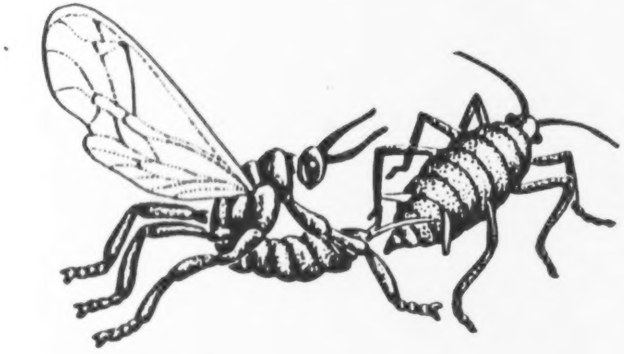

Pupa
Larva
Egg
Adult

7-50

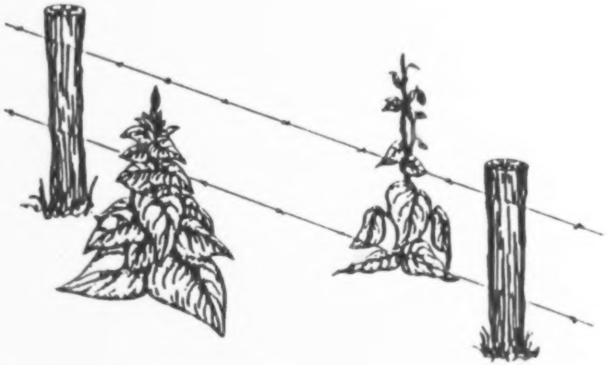
U.S.E.P.A.

T7-8

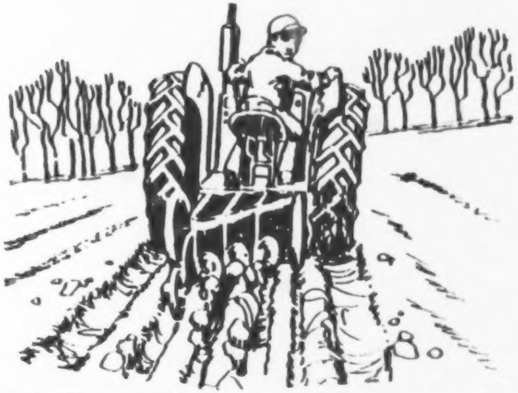
Alternate Control Methods



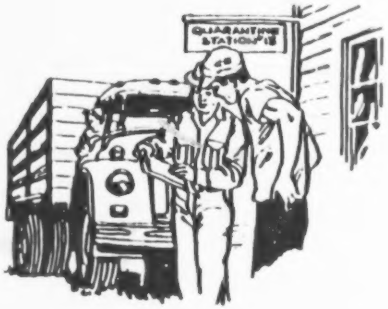
Biological Control



Resistant Varieties



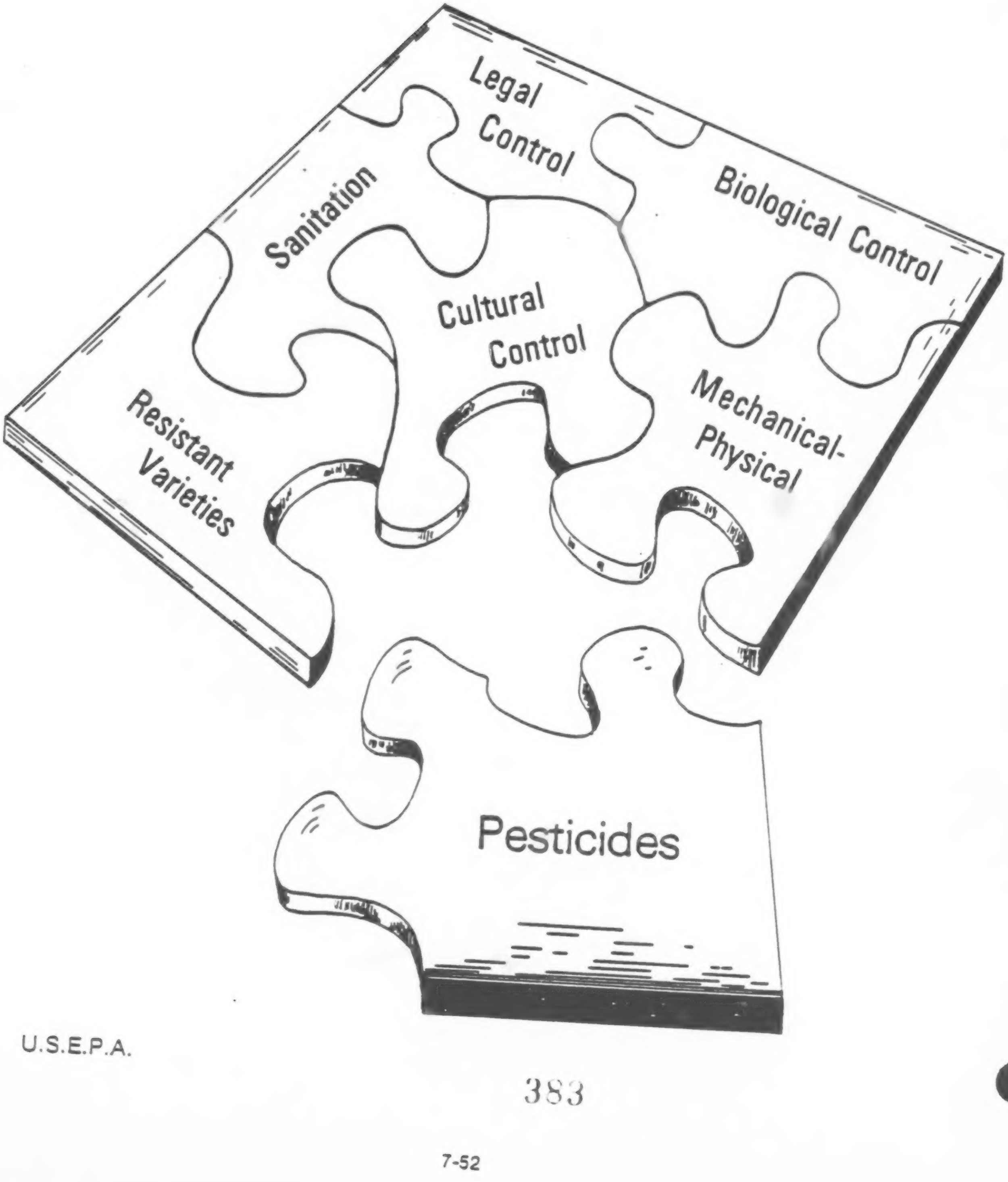
Cultural Control



Legal Control

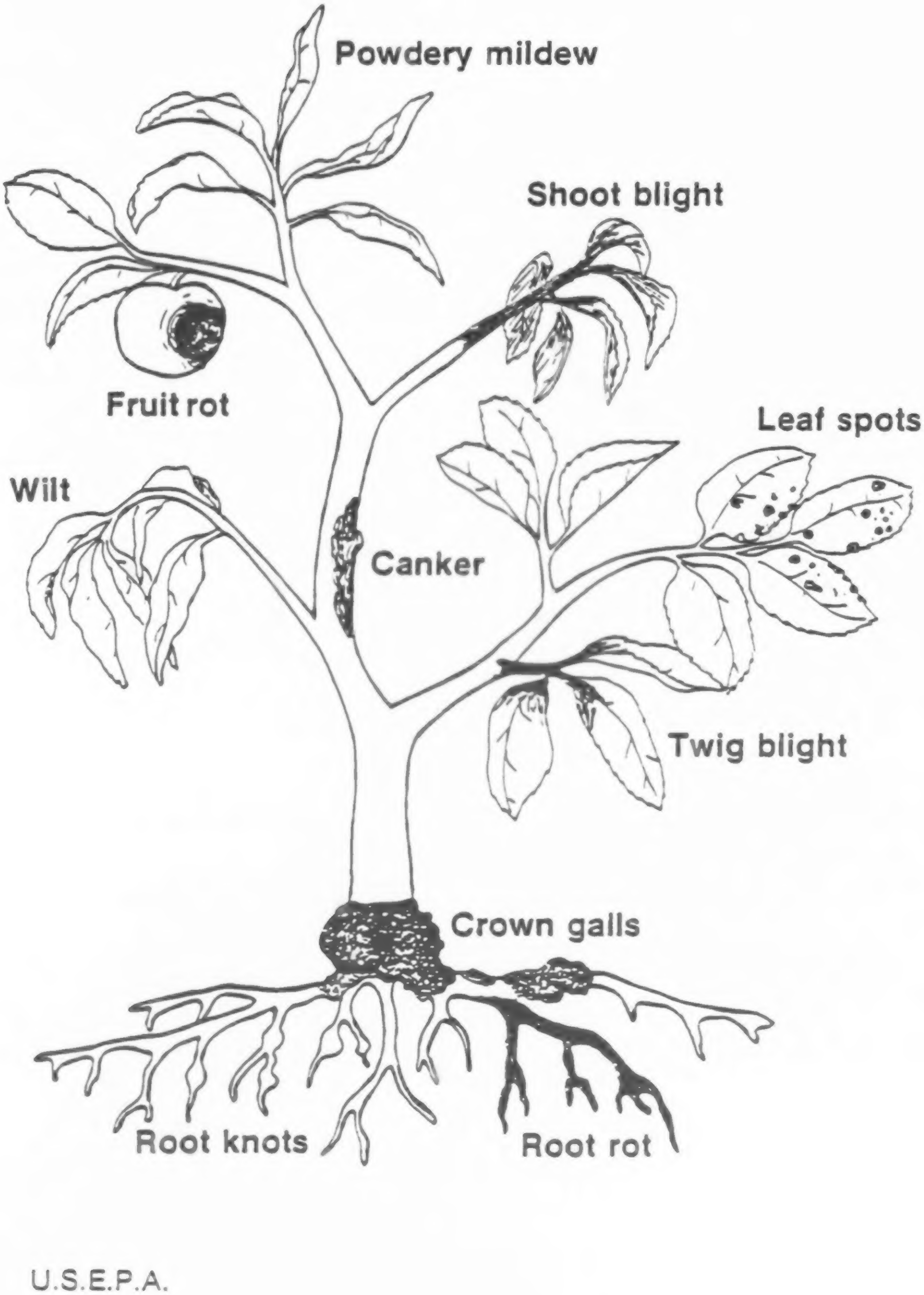
U.S.E.P.A.

Integrated Control


Legal Control
Sanitation
Biological Control
Cultural Control
Mechanical-Physical
Resistant Varieties
Pesticides

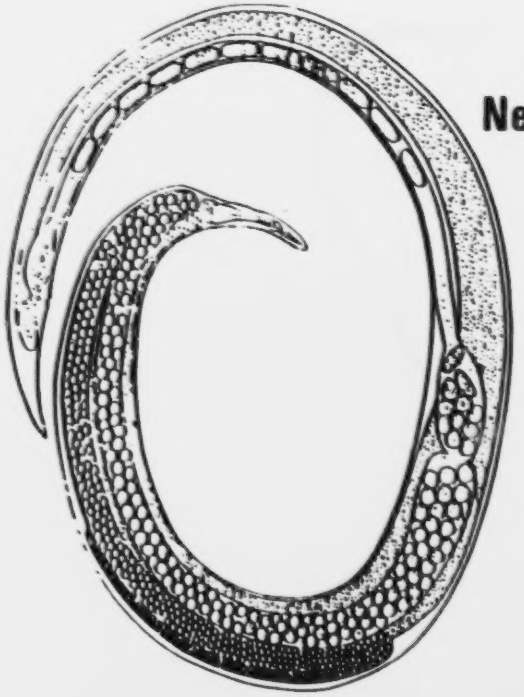
U.S.E.P.A.

Symptoms of Disease

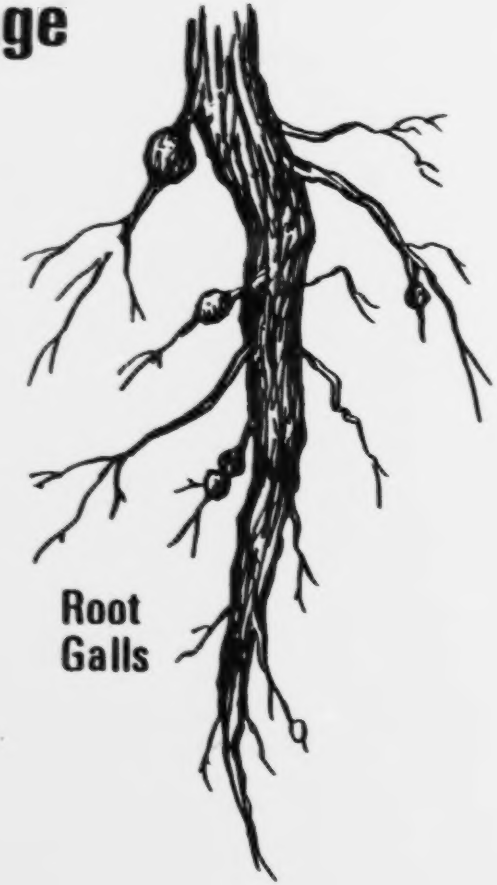

Powdery mildew
Shoot blight
Fruit rot
Leaf spots
Wilt
Canker
Twig blight
Crown galls
Root knots
Root rot

U.S.E.P.A.

Nematode Damage

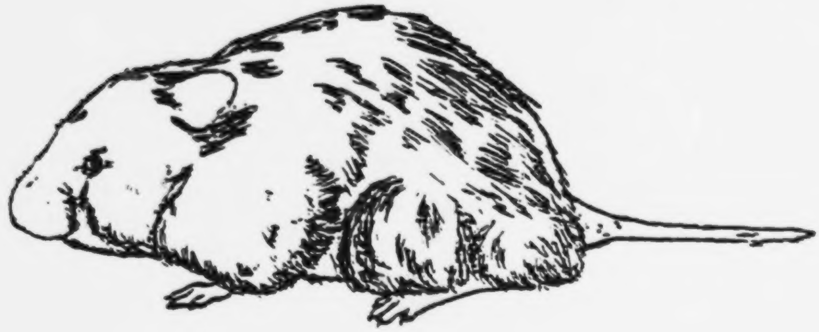


Actual Length Equals 1/50 to 1/25 Inch

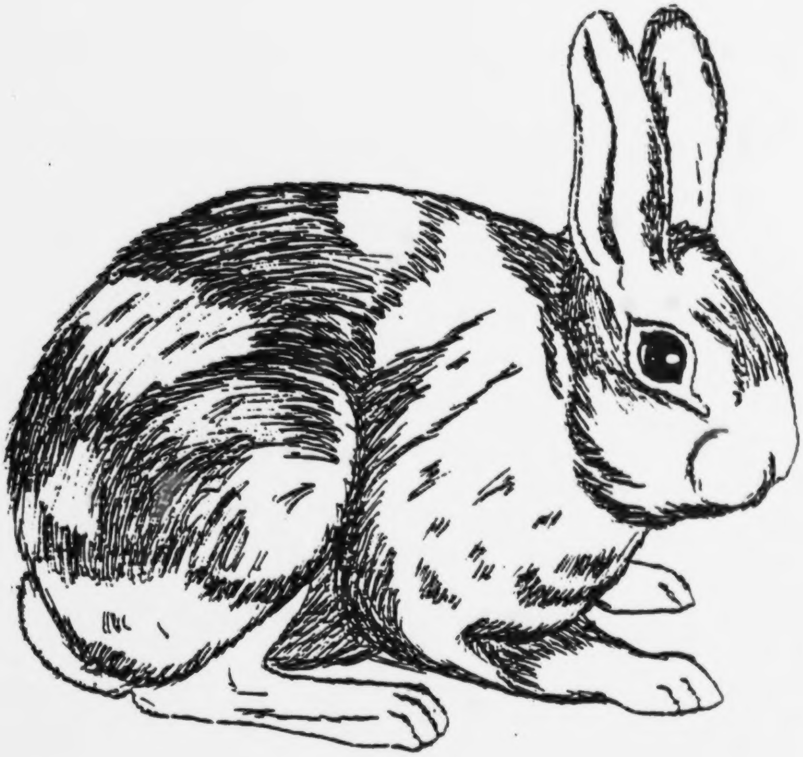


U.S.E.P.A.

Animal Pests



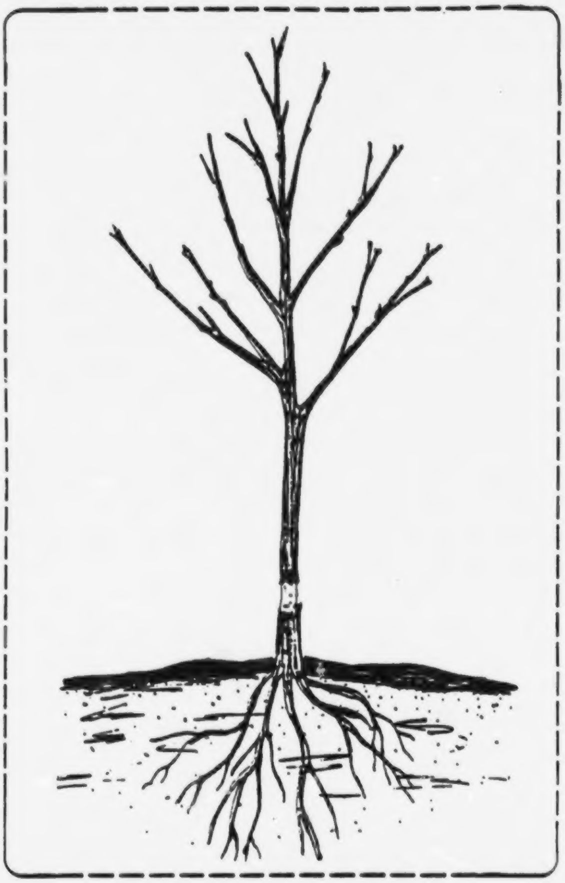
Field Mice



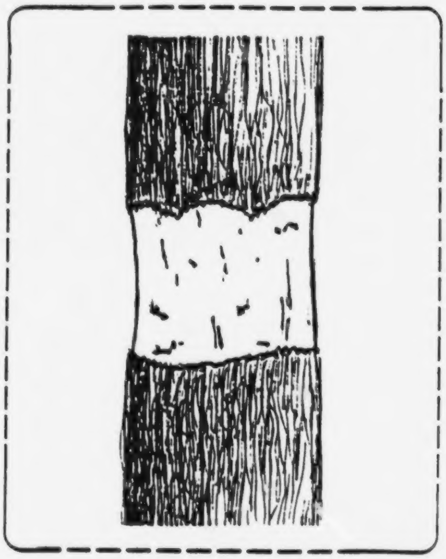
Rabbits

387

Girdling Damage



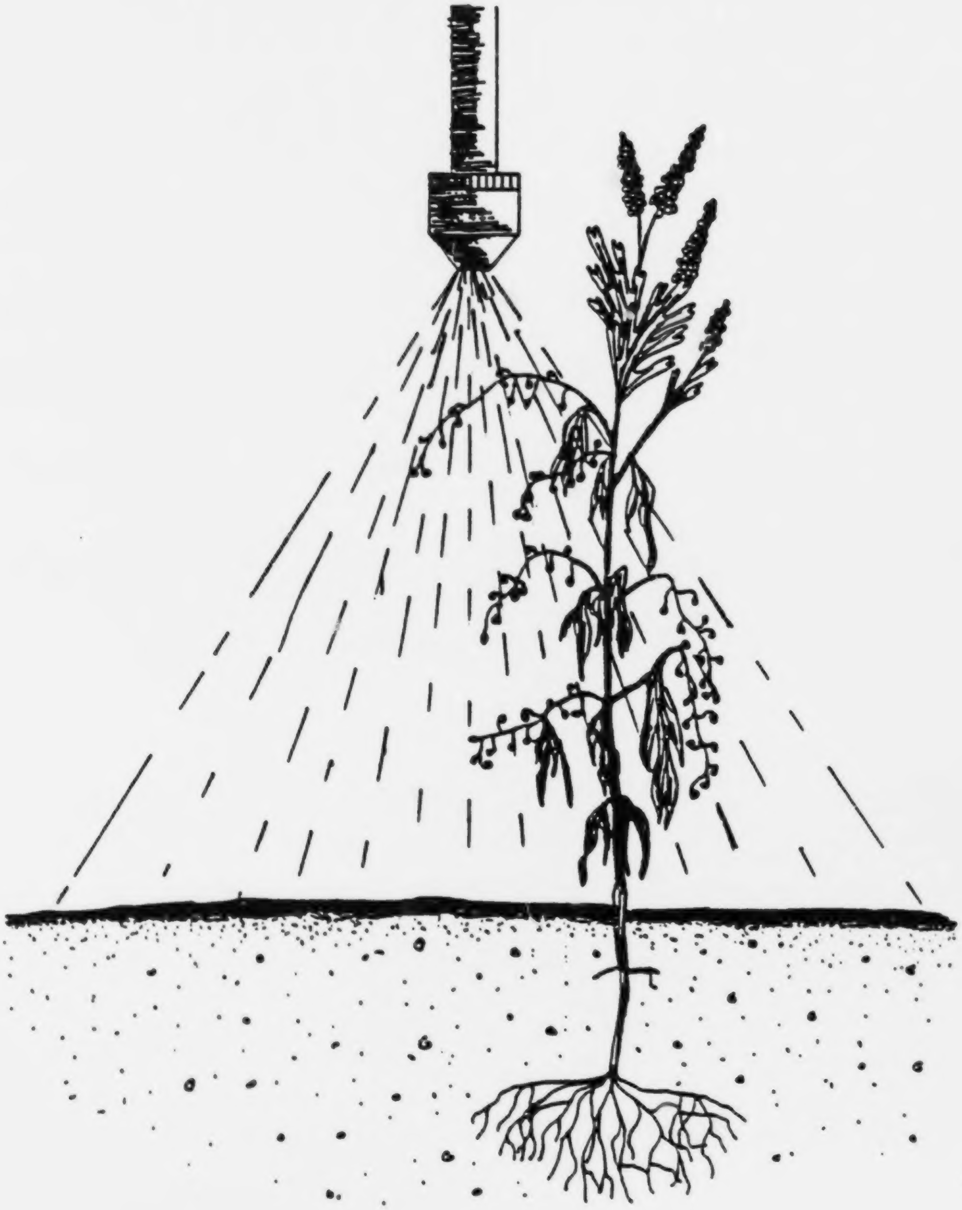
A Young Tree Girdled



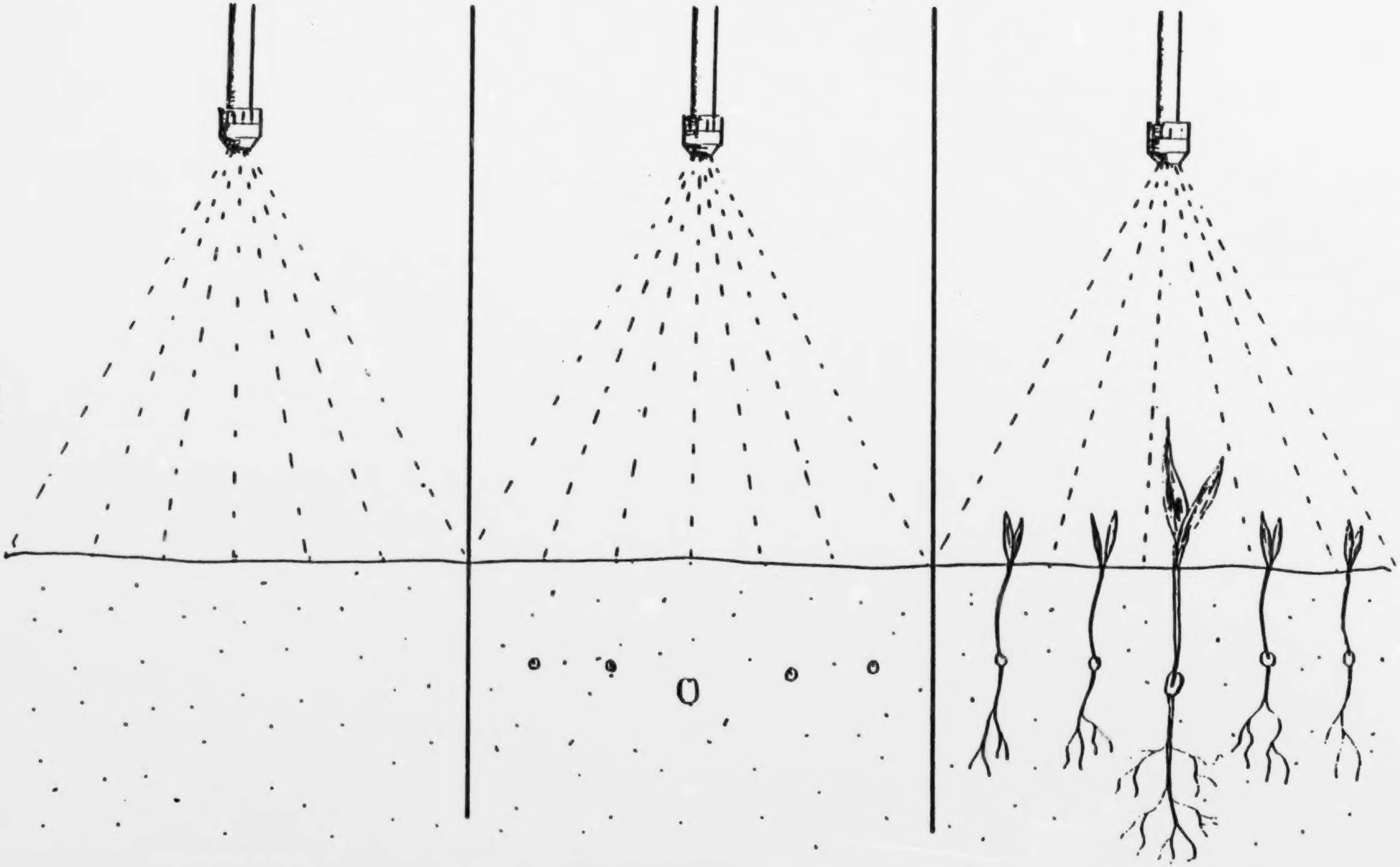
Close-up of Damage

388

Contact Herbicides Kill Only the Part of the Plant They Cover



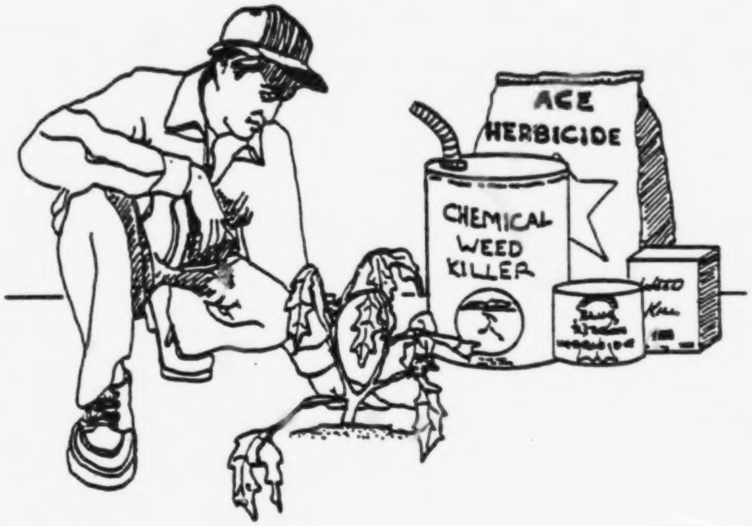
Time of Herbicide Application



Preplant

Preemergence

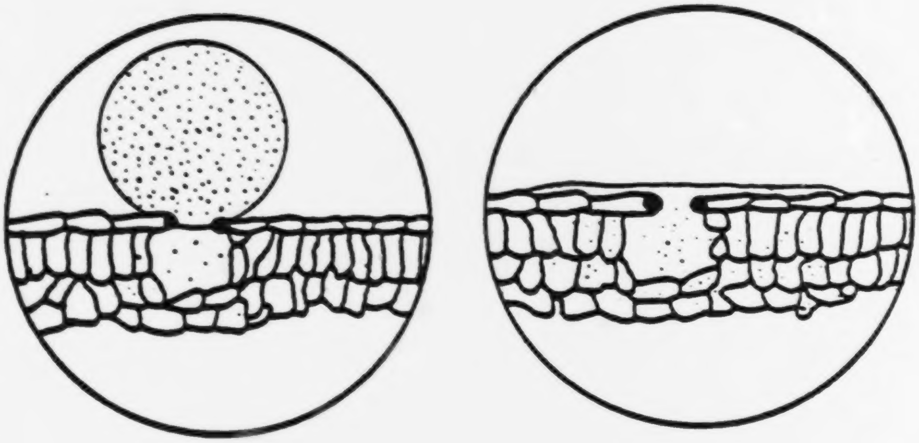
Postemergence


ACE
HERBICIDE
CHEMICAL
WEED
KILLER

**First identify weed.
Then select appropriate herbicide.**

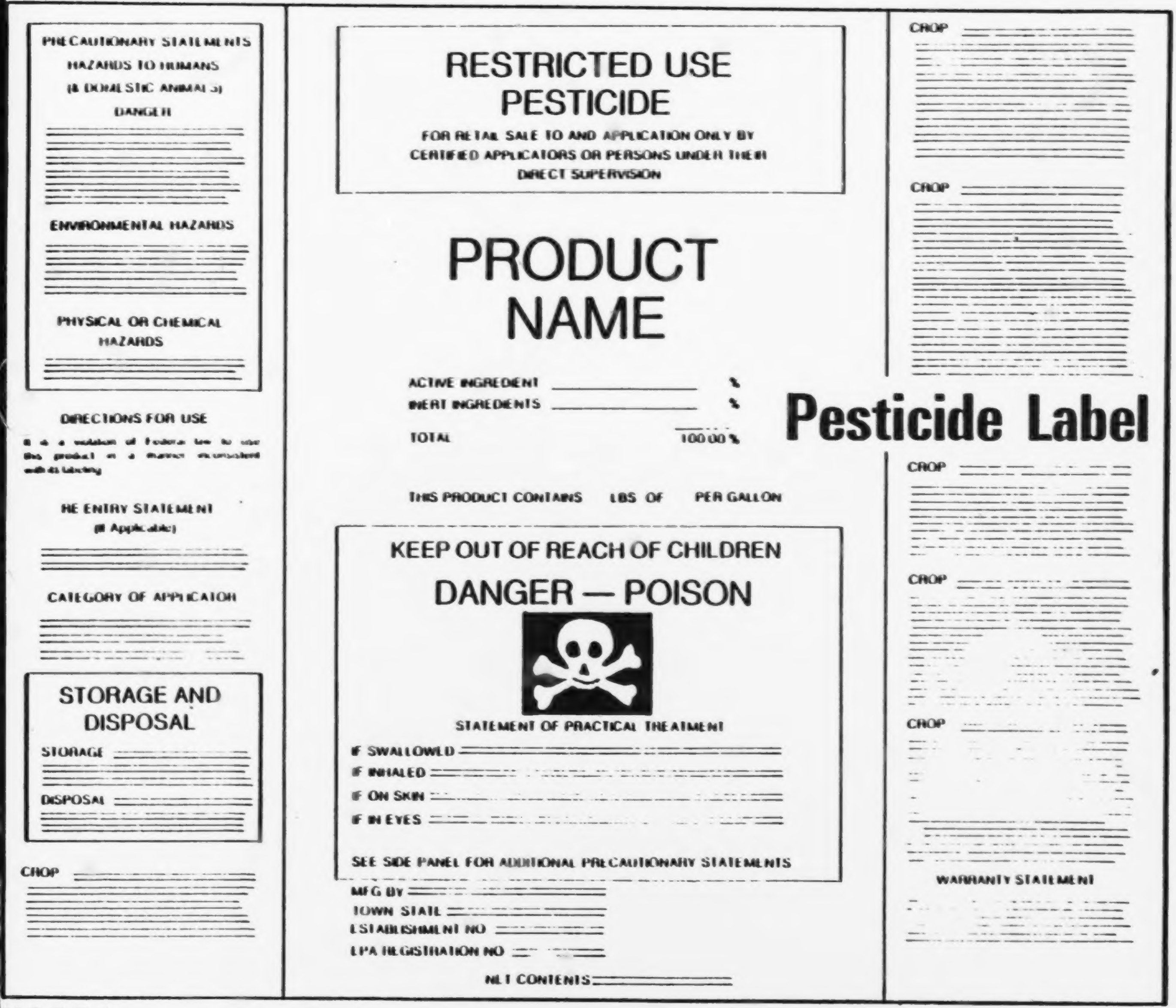
Wetting Agents —

- reduce surface tension of herbicides.
- increase penetration of herbicides.



393

Pesticide Label



PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS
(& DOMESTIC ANIMALS)
DANGER

ENVIRONMENTAL HAZARDS

PHYSICAL OR CHEMICAL HAZARDS

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling

RE ENTRY STATEMENT
(If Applicable)

CATEGORY OF APPLICATOR

STORAGE AND DISPOSAL

STORAGE

DISPOSAL

CROP

RESTRICTED USE PESTICIDE

FOR RETAIL SALE TO AND APPLICATION ONLY BY CERTIFIED APPLICATORS OR PERSONS UNDER THEIR DIRECT SUPERVISION

PRODUCT NAME

ACTIVE INGREDIENT ______ %
INERT INGREDIENTS ______ %
TOTAL 100.00 %

THIS PRODUCT CONTAINS LBS OF PER GALLON

KEEP OUT OF REACH OF CHILDREN

DANGER — POISON

STATEMENT OF PRACTICAL TREATMENT

IF SWALLOWED
IF INHALED
IF ON SKIN
IF IN EYES

SEE SIDE PANEL FOR ADDITIONAL PRECAUTIONARY STATEMENTS

MFG BY
TOWN STATE
ESTABLISHMENT NO
EPA REGISTRATION NO

NET CONTENTS

CROP

CROP

CROP

CROP

CROP

WARRANTY STATEMENT

U.S.E.P.A.

Chevron

ORTHO

ORTHOMITE™ Ornamental Miticide

Active Ingredient:	By Wt.
Hexakis (2-methyl-2-phenylpropyl- distannoxane	50%
Inert Ingredients	50%

DANGER: KEEP OUT OF REACH OF CHILDREN
See other precautions on back panel.

Manufactured for
Chevron Chemical Company
Ortho Agricultural Chemicals Division
San Francisco CA 94119   Richmond CA 94804
Product [illegible]   Made in U.S.A.
Form 5702-A   EPA Est. 239-CA-1
EPA Reg. No. 201-389-AA-239

NET WEIGHT 1 POUND

READ ENTIRE LABEL. USE STRICTLY IN ACCORDANCE WITH CAUTIONS AND DIRECTIONS, AND WITH APPLICABLE STATE AND FEDERAL REGULATIONS.

KEEP PESTICIDE IN ORIGINAL CONTAINER. DO NOT PUT CONCENTRATE OR DILUTE INTO FOOD OR DRINK CONTAINERS.

GENERAL INFORMATION

ORTHOMITE™ Ornamental Miticide is recommended for control of a wide range of plant feeding mites, including strains that are resistant to other miticides. ORTHOMITE™ Ornamental Miticide may be applied when honeybees are present and when beneficial mites are important in integrated control programs. ORTHOMITE™ Ornamental Miticide can readily be dispersed in water and can be used in conventional dilute sprayers or concentrate sprayers. Agitation is required during mixing and spraying. Thorough and complete coverage of foliage is necessary for optimum mite control. This product is compatible with insecticides and fungicides recommended for both greenhouse and outdoor ornamental spray schedules.

Apply this product only as recommended on this label by ground application.

NOTE: This product is sold by weight and package is full when packed, but due to fluffy nature this material is inclined to settle.

DOSAGE RECOMMENDATIONS

Commodity	Mites Controlled	Amount of ORTHOMITE™ Ornamental Miticide Per 100 Gals. of Water	Remarks
Greenhouse & Outdoor Ornamentals (including Nursery Stock)* Greenhouse Flowers and Plants Grown for Propagation Purposes	Spruce Spider (Oligonychus) Two-Spotted Spider	8 to 16 oz.	(1) Do not add oil to the spray solution. (2) Apply when mites appear. Repeat as necessary to maintain control, but not more than once every 28 days. (3) Apply to the foliage only of chrysanthemums (pre-bloom) and poinsettias (prebract).

*For use on non-bearing nursery stock only.

PRECAUTIONS IN USING

DANGER: CORROSIVE. THIS PRODUCT MAY CAUSE SKIN IRRITATION, RESPIRATORY IRRITATION AND EYE DAMAGE. Do not get in eyes, on skin or on clothing. Wear suitable eye protection, such as goggles or safety glasses with side shields or their equivalent when pouring product from container. During commercial application or other prolonged exposure, use goggles and a face mask. Wear clean protective clothing that covers the body well.

Harmful if swallowed. Avoid contamination of food. Avoid breathing dust or spray mist. Wash thoroughly with soap and water after handling, spraying and before eating or smoking.

In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. For eyes, call a physician.

Do not graze or feed animals on cover crops grown in treated areas. Avoid contamination of food, feedstuffs and domestic water supplies.

This product is toxic to fish. Keep out of lakes, ponds and streams. Do not contaminate water by cleaning of equipment or disposal of wastes.

Rinse equipment and dispose of wastes by burying in non-crop land away from water supplies. Dispose of empty containers by burying with wastes or by burning. Dispose of empty containers in accordance with local, state or federal requirements.

Note to *Physicians*: Emergency information — call (415) 233-3737. Probable mucosal damage may contraindicate the use of gastric lavage. Measures against circulatory shock, respiratory depression and convulsion may be needed.

CONDITIONS OF SALE: 1. Chevron Chemical Company (Chevron) warrants that this material conforms to the chemical description on the label and is reasonably fit for use as directed hereon. Chevron neither makes, nor authorizes any agent or representative to make, any other warranty of FITNESS or of MERCHANTABILITY, guarantee or representation, express or implied, concerning this material.

2. Critical and unforeseeable factors beyond Chevron's control prevent it from eliminating all risks in connection with the use of chemicals. Such risks include, but are not limited to, damage to plants and crops to which the material is applied, lack of complete control, and damage caused by drift to other plants or crops. Such risks occur even though the product is reasonably fit for the uses stated hereon and even though label directions are followed. Buyer and user acknowledge and assume all risks and liability (except those assumed by Chevron under 1 above) resulting from handling, storage, and use of this material.

BEST COPY AVAILABLE

Stauffer
CHEMICALS

CAPTAN Garden Spray

FOR PLANT DISEASE CONTROL

ACTIVE INGREDIENT:

CAPTAN N [(trichloromethyl)thio]-4-cyclohexene-1,2-dicarboximide	50%
INERT INGREDIENTS:	50%
	100%

CAUTION **Keep Out of Reach of Children**

Avoid inhalation of dust or spray mist.

Avoid contact with skin.

Do not contaminate food and feed.

STORE IN COOL, DRY PLACE — PROTECT FROM EXCESSIVE HEAT.

CAPTAN GARDEN SPRAY is a microfine wettable powder specially formulated for use in water as a spray for certain fungus diseases of fruits, vegetables and ornamentals. Also useful as a plant dip and seed treatment for the control of certain seed rots and damping-off.

BURN EMPTY BAG — KEEP OUT OF SMOKE

DIRECTIONS FOR MIXING

CAPTAN GARDEN SPRAY is a wettable powder specially formulated to mix easily with water to form a suspension for spray application. Simply add required amount to the water and stir till completely dispersed. If a wetter-spreader is needed on roses or other hard to wet plants, add ½ teaspoonful of household detergent per gallon of spray mixture.

Made in U.S.A.
EPA Reg. No. 476-761

A 1

RECOMMENDATIONS

ORNAMENTALS

AZALEA, CARNATION, CHRYSANTHEMUM (Damping-off) — Dip cuttings in a suspension of 5 tablespoons per gal. of water before bedding. **CARNATION** (Rust, Alternaria Leaf Spot); **CHRYSANTHEMUMS** (Botrytis Flower Blight) — 8 teaspoonfuls per gal. of water. Apply at first sign of disease. Repeat at 7 to 10 day intervals. Use the shorter interval under conditions favorable to infection.

GLADIOLUS, TUBEROUS BEGONIAS (Rot, Damping-off) — 8 tablespoonfuls per gal. of water. Dip bulbs for 30 minutes. Stir, drain and plant. **ROSE** (Black Spot) — 6 teaspoonfuls per gal. of water. Apply at first sign of disease. Repeat at 7 to 10 day intervals. Use the shorter interval under conditions favorable to infection.

LAWNS, TURF (Brown Patch, Damping-off, Leaf Spot, Seed Rot) — 8 teaspoonfuls per gal. of water and apply 1 gal. per 100 sq. ft. of turf. Repeat at 7 to 10 day intervals as needed. For Melting-out use 10 to 17 teaspoonfuls per gal. and apply as above, beginning when grass resumes growth in the spring (March-April). Repeat at 7 to 14 day intervals as long as cool, wet weather persists.

VEGETABLES

CUCURBITS (Angular Leaf Spot, Anthracnose, Downy Mildew) — 8 teaspoonfuls per gal. of water. Apply at 5 to 7 day intervals. Use the shorter interval under conditions favorable to infection.

POTATO (Early and Late Blight), **TOMATO** (Early and Late Blight, Gray Leaf Spot, Septoria Leaf Spot) — 8 teaspoonfuls per gal. of water. Apply at 5 to 7 day intervals. Use the shorter interval under severe infection conditions.

SEED TREATMENT

BEANS, CABBAGE, CORN, MELONS, PEAS, SQUASH (Seed Rot, Damping-off) — ½ to 1 teaspoonful per pound of dry seeds. **BEETS, CHARD, SPINACH, [illegible]** — 1½ to 3 teaspoonfuls per pound of dry seed. Mix thoroughly in paper bag or glass jar.

FRUIT

APPLE (Scab, Fruit Spot, Sooty Blotch, Fly Speck, Frog Eye, Fruit Rots) — 8 teaspoonfuls per gal. of water. Apply at about weekly intervals through petal fall spray, 10 to 14 day intervals on cover sprays.

GRAPE (Downy Mildew, Black Rot) — 8 teaspoonfuls per gal. of water. Apply just before bloom, just after bloom and 7 to 10 days after bloom. Make an additional application 2 to 3 weeks later for downy mildew. Dead Arm (current season infections) — 8 teaspoonfuls per gal. of water. Apply when shoots are 1 to 2 inches long. Repeat application when shoots are 4 to 6 inches long.

PEACH (Brown Rot, Scab) — 8 teaspoonfuls per gal. of water in blossom, shuck and cover sprays.

RASPBERRY (Botrytis Fruit Rot) — 3 teaspoonfuls per gal. of water. Begin application in first bloom. Make 2 repeat applications, or more frequently as field conditions warrant, at approximately 10-15 day intervals. Make thorough coverage, applying spray to point of drip.

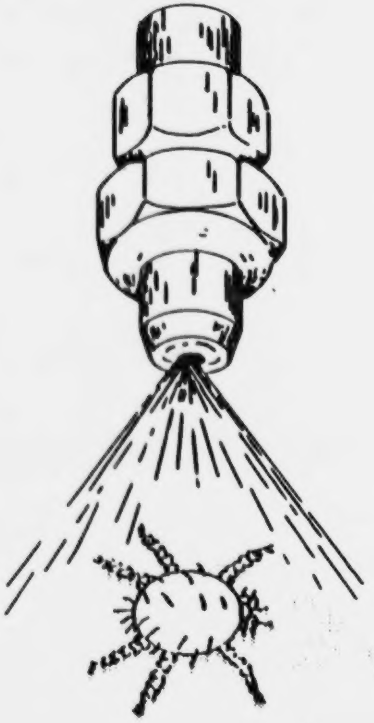
STRAWBERRY (Botrytis Rot) — 8 teaspoonfuls per gal. of water. Make first application as soon as new growth starts and repeat at 7 day intervals to harvest. Under severe infection conditions apply immediately after each picking through harvest.

NOTICE: Stauffer Chemical Company makes no warranty, express or implied, including the warranties of merchantability and/or fitness for any particular purpose, concerning this material, except those which are contained on Stauffer's label.

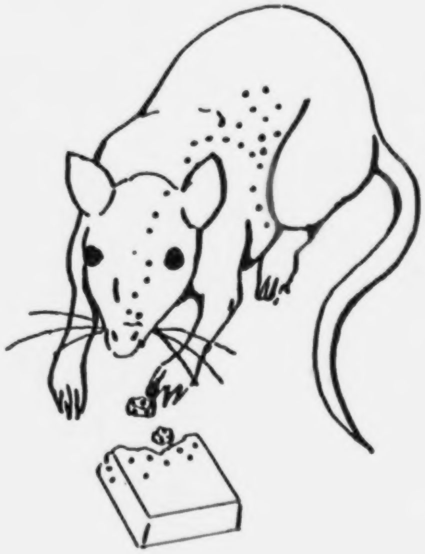
STAUFFER CHEMICAL COMPANY WESTPORT, CT 06880

BEST COPY AVAILABLE

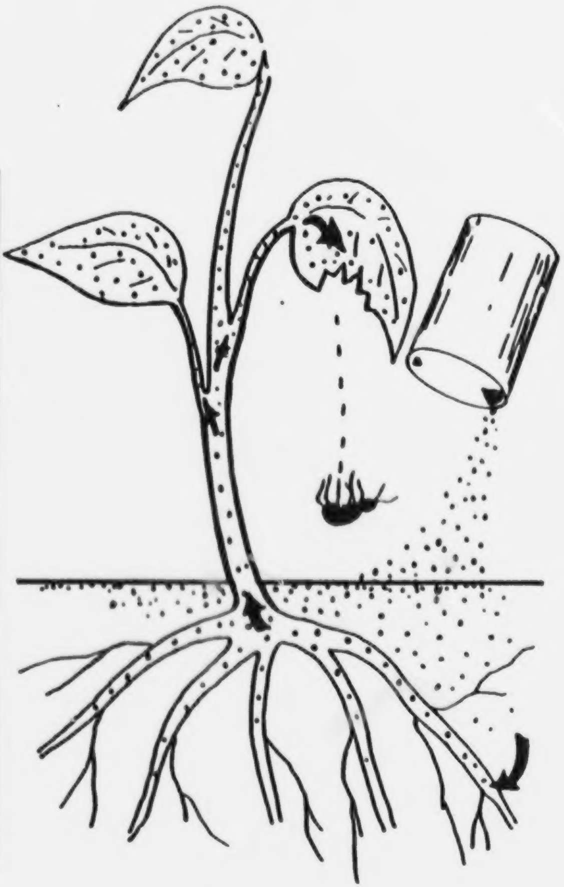
Ways Pesticides Attack Pests



Contact Poison



Stomach Poison



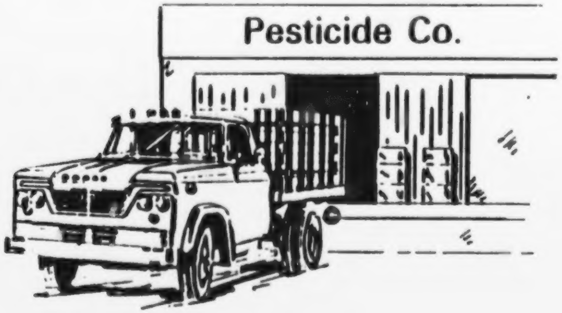
Systemic Poison

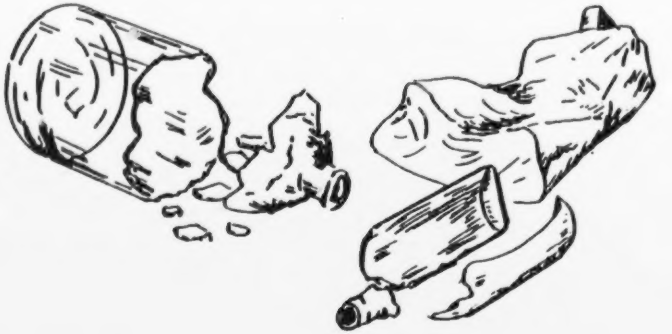
7-64

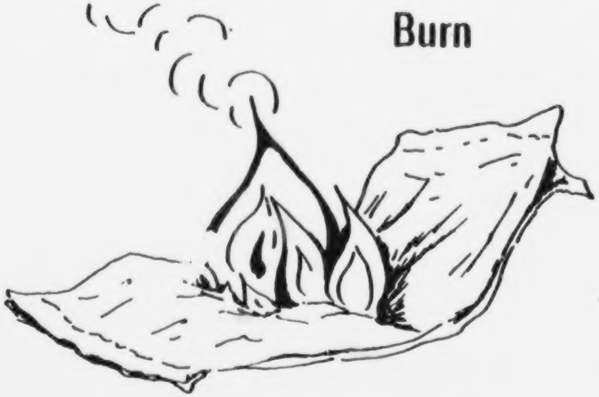
T7-22

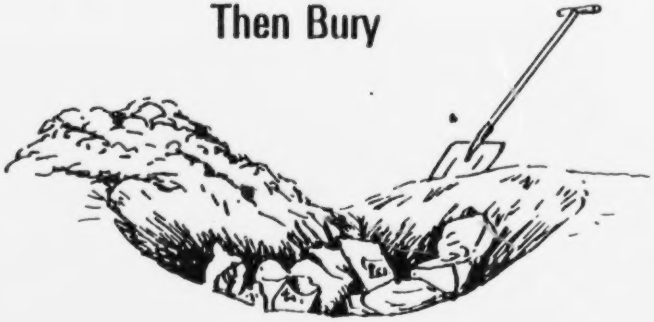
U.S.E.P.A.

Disposal of Containers


Recycling
Pesticide Co.

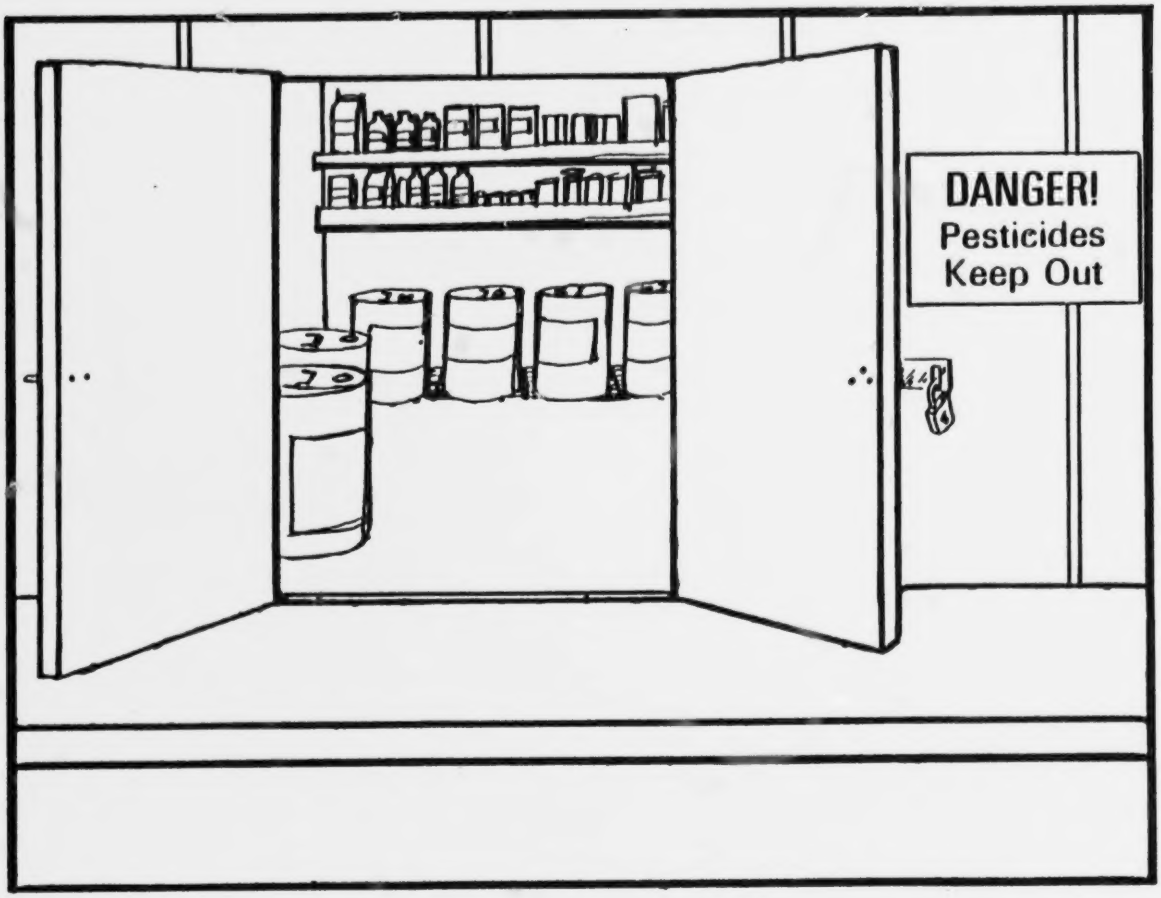

Break, Crush, or Cut Apart


Burn


Then Bury

U.S.E.P.A.

Storage Area


DANGER!
Pesticides
Keep Out

U.S.E.P.A.

CHAPTER 8

STORING, GRADING, AND MARKETING NURSERY STOCK

PERFORMANCE CHECK LIST

1. List the types of storage used for nursery stock.
2. Demonstrate the techniques of defoliation of plants before storage.
3. List and describe the problems that might occur with plants while in storage.
4. Demonstrate the process of grading with calipers.
5. Define marketing as it is interpreted in the nursery industry.
6. List and describe the five types of firms that market nursery stock.
7. List several ways nursery operators advertise their products.
8. Define merchandising as it applies to the nursery industry.
9. Demonstrate the process of preparing plants for shipment by mail order nurseries.
10. Demonstrate the process of preparing plants for shipment by wholesale nurseries.

SUGGESTED LEARNING ACTIVITIES

1. Visit several commercial nurseries and determine how they store, grade, and market their nursery stock.
2. Prepare some nursery stock for storage.
3. Construct a polyethylene-covered quonset greenhouse for storage of container-grown stock.
4. Practice grading nursery stock using a caliper.
5. Make a list of all the wholesale nursery firms, landscape firms, and other retail nursery businesses in your area.
6. Check newspapers and other media and make a list of the ways in which local nursery firms advertise.
7. Have students construct a lath house for display or storage of plant material.
8. Visit a local retail nursery and make a list of the merchandising procedures this firm uses.
9. A nursery firm advertises in many ways. Some of the more typical methods include newspapers, radio or television commercials, direct mail, and good public relations. Choose one or more of these methods and advertise the plant material or services provided by your school horticulture department.
    - A. Place an ad in the school or community newspaper.
    - B. Have a local radio or TV station do a public service announcement about a sale sponsored by your horticulture department.
    - C. Create a brochure or flier publicizing a special sale or service offered by your horticulture department and mail it (or distribute it by hand) to parents, teachers, and others in the community.

(continued)

D. Practice good public relations by:

- Writing a horticulture information column for the school or local newspaper.
- Providing a horticulture information spot for a local radio station. For example, tell listeners how to control crabgrass in the spring. Or help the radio station start a "Green Thumb" hour designed to give listeners the chance to call in with questions.
- Developing a speakers' bureau. Have members of your class who excel in public speaking give talks at local garden club meetings, etc.

SAMPLE INTEREST APPROACH

Bring in a newly harvested nursery plant. Ask students how this plant can be kept in good condition for a customer who may not want delivery for several months. Ask students why nursery operators don't simply harvest their stock as it is ordered. Why is it sometimes necessary to store stock before shipping or selling it? Ask students how storage of container stock differs from that of bareroot stock. When students cannot answer these questions, move into a discussion of nursery stock storage.

Ask students why nursery stock needs to be graded. When they cannot answer, show them several nursery plants of the same variety but different sizes. Discuss the differences in these plants — height, diameter, size, etc. Ask students how you can make sure that the grades one nursery operator assigns to plants are the same as those another nursery operator would assign to similar plants. When they cannot answer, move into a discussion of grading procedures.

Bring in a small sack of groceries. Remove the groceries from the bag, then ask students what the term "marketing" means. When we refer to marketing of nursery stock, is this what we mean? When students say this is not the way nursery stock is marketed, move into a discussion of commercial marketing procedures, advertising and merchandising.

Ask students several questions about advertising. Let's say there are two nurseries in the same town. Both nurseries have similar stock — same varieties, same sizes, same quality. Yet one nursery sells far more than does the other one. What are some possible reasons for this? Move into a discussion of marketing, merchandising and advertising.

NAME ____________________

KEY QUESTIONS FOR CHAPTER 8

1. How does common storage of nursery stock differ from cold or refrigerated storage? (pages 195-197)

2. How is nursery stock defoliated before storage? (page 198)

3. What is the purpose of "sweating" nursery stock and how is it done? (page 198)

4. Why should the roots of stored plants be covered? (page 198)

5. How can the growth of mold in storage be prevented? (pages 198-199)

6. How is container-grown nursery stock stored? (page 199)

7. How are herbaceous perennials stored and prepared for shipment? (page 199)

8. What is "caliper"? (page 200)

9. Why is nursery stock graded? Who sets the standards? (page 200)

(continued)

Key Questions *(continued)*

10. Differentiate among marketing, advertising, and merchandising. (glossary)

NAME ____________________

TERMS TO REMEMBER
Chapter 8

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to the pages (given in parentheses) in Chapter 8 of *The Nursery Worker*.

Technical Vocabulary

advertising
caliper
defoliation
grading
herbaceous perennial
inventory
marketing
mechanized beater
merchandising
pallet
rick

____________________ 1. All activities by which transfer or possession of goods from seller to buyer is effected. (page 201)

____________________ 2. All planning, advertising, and other activities involved in promoting sale of a product. (page 203)

____________________ 3. To describe or present a product or service in order to induce consumers to buy it. (page 202)

____________________ 4. A detailed list of articles. (glossary)

____________________ 5. A perennial plant that does not develop a woody stem. (glossary)

____________________ 6. A stack or pile of nursery material. (page 198)

____________________ 7. A shallow platform for holding material for storage or transportation. (page 198)

____________________ 8. In landscape or nursery usage, the diameter of a tree measured six inches above the ground for smaller trees, or twelve inches above the ground for larger trees. (page 200)

____________________ 9. The process of losing leaves. (page 198)

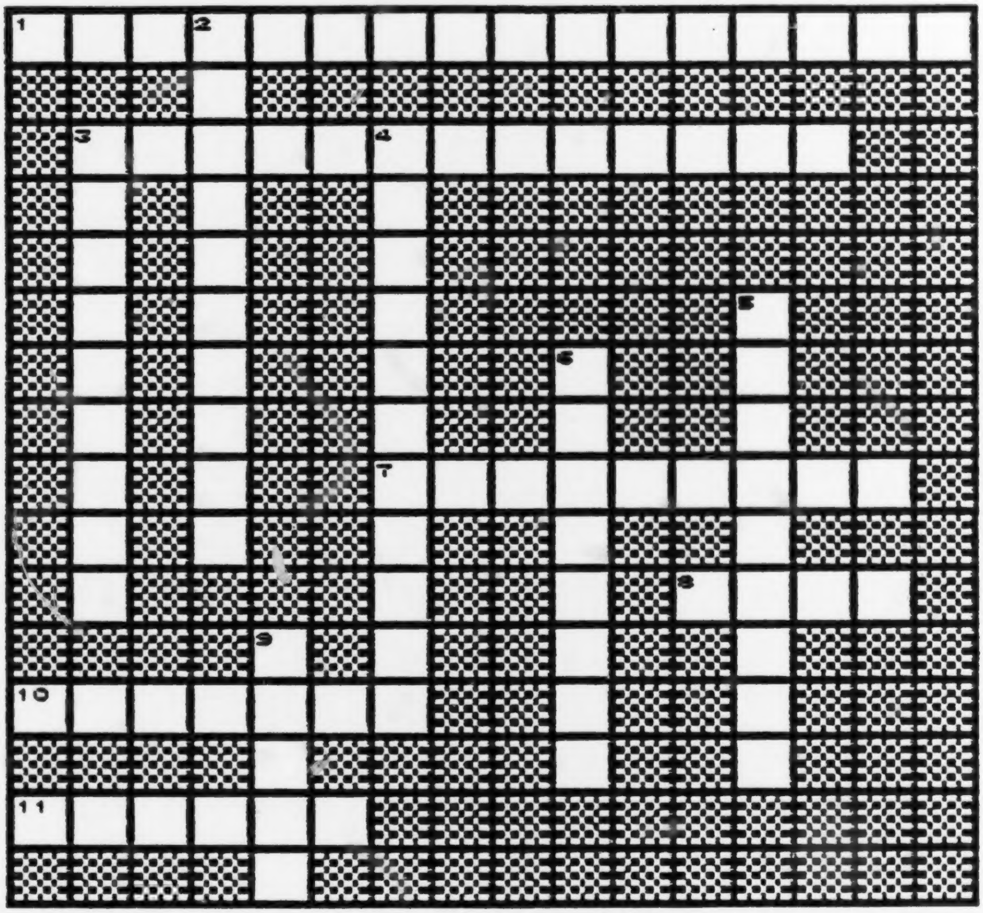
____________________ 10. A mechanical device used to remove foliage from plant material. (page 198)

____________________ 11. Arranging or sorting plants according to quality or size. (page 200)

NAME ______________________

CROSSWORD PUZZLE 8

Fill in the crossword puzzle with the missing words. If you need help, refer to the pages (given in parentheses) in Chapter 8 of *The Nursery Worker*.



ACROSS Clues

1. A device used to remove leaves from plants (2 words). (page 198)
3. An attempt to increase sales with attractive presentation or display. (page 203)
7. A list of stock on hand. (glossary)
8. A stack or pile of nursery material. (page 198)
10. Sorting plants according to quality or size. (page 200)
11. A platform for storage or transportation of materials. (page 198)

DOWN Clues

2. A plant which does not develop woody tissue is said to be ________ (glossary)
3. All the functions involved in buying or selling goods or services. (page 201)
4. A form of public announcement intended to aid in the sale of merchandise or services. (page 202)
5. To remove leaves. (page 198)
6. The exudation of moisture from green plants when closely packed. (page 198)
9. A small plant placed in a field row. (page 127)

NAME ____________________

LETTER MAZE 8

The 10 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
W X I N H K G P L R R T E O M W L K C T D V L
D F L J P D M U A E G A T V V J H D Q B P Z S
Q S X S P M U B Y L J P B O Y J P F W M D N S
B N U H A H N P R F L K X L N Q V T J T H G M
J W X H A D D A I Z Z E B Z F S X Y N W H F N
I R V E C J K N H S T O T G G R A D I N G Y O
U R M B B M N D U D O T C N W F O Y O U B O N
I R O N X T L O C X P C Z O I F D G X F M W I
J P G B Y V E M R A N R A N U J M W V M O Q Y
V Q E I M C D A O I P J Z F S M K F U F J S O
G S R R A G P R X Q R I E Z W E C G M T M Z Q
B Z B B E L C K G J J K I K A R G R K Z N N R
S X R W G N W E J K Q F L N E C V I L J I E W
K E M U T O N T C E G R A X B H K H A N P S A
H M S L E A I I U G M F D A F A Y K K I B J M
P I C T N M G N A H T M V O G N X R L Z A S Y
T L M W F S L G N L G A E C P D X A T Z C R Z
Y D E F O L I A T I O N R K N I C Q C T O N T
G Z Y K L E V J U Z B F T E D S D Z I T A Y D
Y G X R V P O G X O F A I V I I K C N H A P T
Y A G V U W X D Q B O J S N O N K E S H L P Y
W S F O K X D Q I L P V E W E G V S I G N A D
S Y Z H V R T S T Q Q K W X T N R S U W R B X
H I G F Z Q C V M O B Q D G I N U T P K Q A I
```

ADVERTISE
CALIPER
DEFOLIATION
GRADING
HERBACEOUS
INVENTORY
MARKETING
MERCHANDISING
PALLET
PERENNIAL

NAME ____________________

STUDENT EXERCISE 8-A

MERCHANDISING NURSERY STOCK

The way in which stock is displayed plays a major role in what a customer purchases. In this exercise you will practice displaying nursery stock using various merchandising techniques to attract customers.

MATERIALS:

- nursery stock
- related items that might be sold in a garden center
- suitable area for display
- material for making signs:
  - — poster board
  - — magic markers

PROCEDURE:

1. Locate a suitable area for a display. Make sure the area is clean.
2. Place seasonal items and/or impulse items near the door or in a high traffic area. For example, place a display of seeds near the door in spring. Use a bulb display in the fall. Other impulse items could be located near the check-out.
3. Place appropriate nursery stock in the display area and surround it with related items. For example, place rose fertilizer, fungicide for blackspot and mildew control, and pruning shears near a display of rose plants.
4. Construct posters and place them near the plants, on the walls, etc. Posters may include photographs of mature plants, suggestions on how to use the plant in the landscape, suggestions on how to care for the plant, etc.
5. If care tags are available, attach them to the plants.
6. Price the plants and other merchandise.
7. Analyze your completed display. Is it attractive? Would it encourage a customer to purchase a given item? If possible, have people from outside the class come in and critique the display. What do they like about it? Would they be inclined to purchase one of the displayed items?
8. When you have completed this exercise, be sure to put away all plant material and other items. Leave the display area clean.

EVALUATION:

1. Seasonal and related items are grouped together. ____________
2. Impulse items are placed in high traffic areas. ____________
3. Posters and advertising materials are appropriately placed. ____________
4. Materials are clearly labeled with price and with care tags where applicable. ____________
5. Area used for the exercise was left clean and neat. All materials were put away properly. ____________

FINAL GRADE ________

NAME ____________________

STUDENT EXERCISE 8-B

EXTERNAL APPEARANCE OF A NURSERY

Customers are often attracted into a nursery or garden center by the outward appearance of the business place rather than by the actual quality of the plant material. Customers may associate an unattractive setting with poor quality. In this exercise you will be asked to survey a local nursery/garden center business and determine how well this firm is doing at creating an attractive setting.

MATERIALS:

- check list (below)
- sharp #2 pencil with eraser
- transportation to a local business

PROCEDURE:

Take copies of the following check list along when you visit a local nursery/garden center firm. Rate the success of this business in attracting customers.

CHECK LIST

	YES	TO SOME EXTENT	NO
1. Flowers or decorative plants are used around the buildings.			
2. The buildings or nursery areas are surrounded by an attractive lawn or suitable ground cover.			
3. Weeds in the driveway, parking lot, around the buildings, etc. have been removed.			
4. All structures and sales areas are neatly painted, or of attractive material not needing paint.			
5. Signs are neatly painted and legible.			
6. Perishable merchandise is fresh-looking, not damaged by sun, wind, frost, etc.			
7. Ample parking is provided for customers.			
(Add your own criterion here)			
8. ____________________			

Compare and discuss your check lists upon returning to school.

EVALUATION:

Check list was completed accurately. ____________

FINAL GRADE ________

NAME ____________________

QUIZ - CHAPTER 8

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T."

T F 1. In the Midwest harvesting of nursery stock typically begins after the first light frost.

T F 2. In common storage no mechanical refrigeration is used for cooling.

T F 3. It is important to harvest nursery stock **before** plant tissues become mature.

T F 4. Deciduous plants should be defoliated before storage.

T F 5. Low plastic greenhouses often serve as winter storage facilities for container stock.

T F 6. Ventilation of container stock storage facilities is not necessary.

T F 7. Grading is arranging or sorting plants according to quality or size.

T F 8. Caliper is the diameter of a tree.

T F 9. A caliper is an instrument used to measure the diameter of a tree.

T F 10. Advertising can let people know that your nursery offers a special kind of plant or service.

T F 11. Merchandising refers to the process of moving plants from one growing area to another.

MULTIPLE CHOICE

Read each item and decide which choice answers the question or completes the statement. Circle the letter of the correct answer.

12. Which of the following procedures can be used to defoliate plants prior to storage?

    A. chemical sprays
    B. mechanical beaters
    C. gas chambers
    D. all of the above

13. Relative humidity of ________ percent is needed for optimum storage conditions.

    A. 30-35%
    B. 50-55%
    C. 80-85%
    D. 95-100%

14. Which of the following would **not** help to control mold in storage?

    A. placing only clean, disease-free stock in storage
    B. "sweating" the stored stock
    C. dusting all plants with fungicide before storage
    D. installing ultraviolet lights in storage areas

15. You can defoliate nursery stock before storage by . . .

    A. chemical sprays and/or gas chambers
    B. sweating
    C. mechanical beaters
    D. all of the above

16. The initials **AAN** stand for . . .

    A. Apple Association of North America
    B. American Association of Nurserymen
    C. American Agronomy News
    D. Association of American Nurseries

(continued)

QUIZ - page 2

17. Arranging or sorting plants according to quality or size is called . . .

    A. grading
    B. calibrating
    C. marketing
    D. both A and C

18. Plant tags are used . . .

    A. to give customers instructions for planting
    B. so that a customer will know what kind of plant it is
    C. so that a price can be put on each plant
    D. for all of the above reasons

19. Retail nursery businesses include . . .

    A. garden centers
    B. discount stores with garden centers only part of the year
    C. mail order nurseries
    D. all of the above

20. The largest percentage of businesses in the nursery industry are . . .

    A. landscape firms
    B. landscape maintenance firms
    C. wholesale firms
    D. mail order firms

ANSWER KEY - CHAPTER 8

Key Questions - page 8-3

1. Common storage of nursery stock involves no mechanical refrigeration equipment. Refrigerated storage, as the name implies, involves the use of cooling equipment to keep plants at the proper temperature.
2. Nursery stock can be defoliated by: (1) chemical sprays, (2) mechanical beaters, (3) gas chambers, or (4) sweating.
3. During sweating nursery stock is loosely bundled, piled into temporary stacks, and thoroughly watered. Buildup of heat causes leaf removal (defoliation), which is necessary before storage.
4. The roots of stored plants should be covered to prevent drying out of the root system.
5. Problems with mold in the storage of plant material can be prevented by placing only clean, disease-free stock in storage. Some nursery operators also dust the plants with fungicide before storage or use ultraviolet lights in the storage area.
6. Container-grown stock is generally stored in low plastic greenhouses.
7. Many herbaceous perennials are stored in temperatures below freezing. Before shipment the frozen plants are placed in a refrigerated room above freezing for about 3 days to thaw slowly.
8. A caliper is an instrument used to measure the diameter of a tree. The term "caliper" also refers to the measurement of the tree.
9. Nursery stock is graded in order to sort plants according to quality or size. Grading standards are recommended by the American Association of Nurserymen.
10. *Marketing* refers to all activities by which transfer of title or possession of goods from seller to buyer is effected. It includes advertising, shipping, storing, and selling. *Advertising* refers to the description or presentation of a product or service in order to induce customers to buy it. *Merchandising* refers to all planning, advertising, and other activities involved in promoting sale of a product.

Terms to Remember - page 8-5

1. marketing
2. merchandising
3. advertising
4. inventory
5. herbaceous perennial
6. rick
7. pallet
8. caliper
9. defoliation
10. mechanized beater
11. grading

Crossword Puzzle 8 - page 8-6

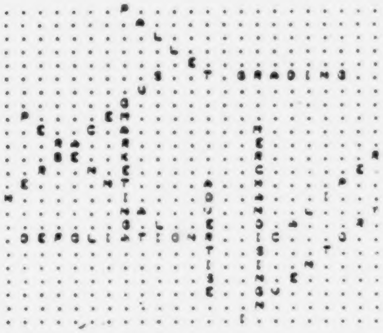
ACROSS

1. mechanical beater
3. merchandising
7. inventory
8. rick
10. grading
11. pallet

DOWN

2. herbaceous
3. marketing
4. advertising
5. defoliate
6. sweating
9. liner

Letter Maze 8 - page 8-7



QUIZ

True or False - page 8-10

1. true
2. true
3. false
4. true
5. true
6. false
7. true
8. true
9. true
10. true
11. false

Multiple Choice - page 8-10

12. D
13. C
14. B
15. D
16. B
17. A
18. D
19. D
20. C

GLOSSARY - Chapter 8

advertising - describing or presenting a product or service in order to induce consumers to buy it.

caliper - in landscape and nursery usage, the measurement of tree diameter taken 6 inches above the ground if the diameter is less than 4 inches; taken 12 inches above the ground if the diameter is over 4 inches. Also an instrument used to measure the diameter of a tree.

defoliation - the process of losing leaves.

grading - arranging or sorting plants according to quality or size.

herbaceous perennial - a perennial plant that does not develop a woody stem.

inventory - a detailed list of articles, typically including code number, quantity, and value of each item.

marketing - all activities by which transfer of title or possession of goods from seller to buyer is effected. Includes advertising, shipping, storing, and selling.

mechanized beater - a mechanical device used to remove leaves from nursery stock prior to storage.

merchandising - all planning, advertising, and other activities involved in promoting sale of a product.

pallet - a platform (usually wooden) for holding material for storage or transportation, as in a warehouse.

rick - a large stack or pile of material such as hay or straw.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 8

T8-1 *(Student Manual*, pages 195-199)

A properly insulated, underground building is an ideal structure for storage of nursery stock. No mechanical refrigeration equipment is used for cooling in this type of storage.

Question: What other types of storage facilities might a nursery use?

T8-2 *(Student Manual*, pages 195-196)

Use of air-cooling frame storage buildings is still the practice in some nurseries. Fans are used in the upper part of these frame structures to pull cool air through the stored materials.

T8-3 *(Student Manual*, page 199)

Herbaceous perennials are divided into several groups according to their root system. Grouping plants in this way can make handling and storage easier.

T8-4 *(Student Manual*, page 200)

Caliper is the determining measurement in grading trees. A caliper measurement of the trunk is taken 6 inches above the ground level up to and including 4-inch trunk size. It is taken 12 inches above the ground level for larger trees.

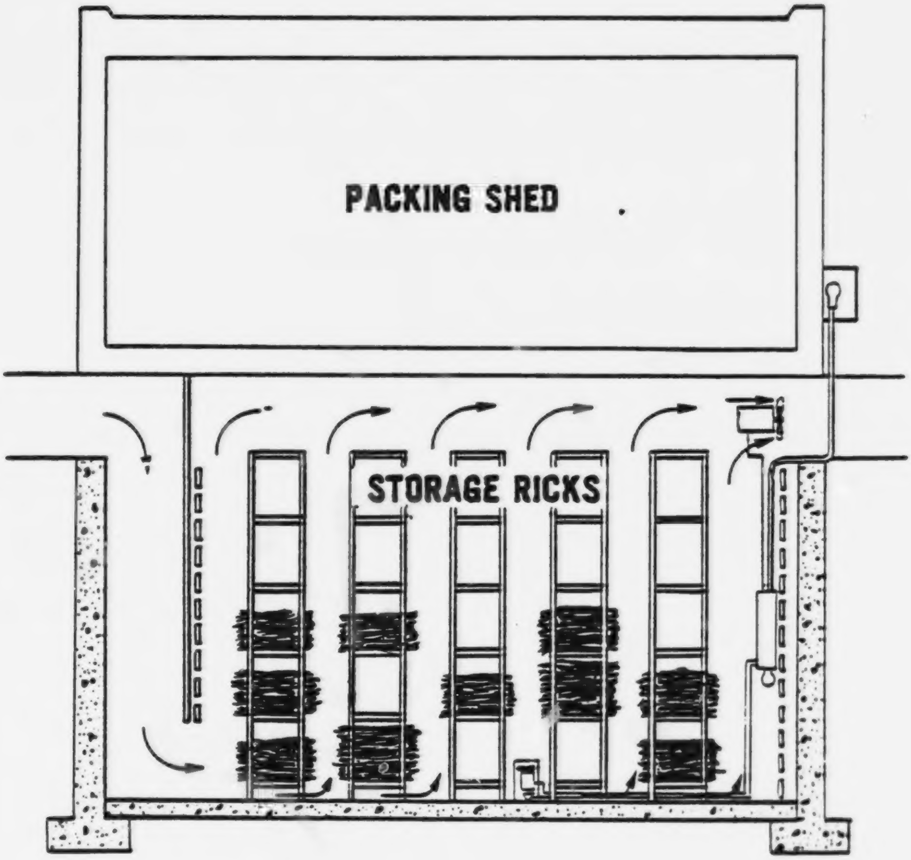
T8-5 *(Student Manual*, page 200)

An instrument called a caliper is used to determine tree diameter. The caliper is held to the tree at the proper height. The diameter of the tree is read on the scale provided.

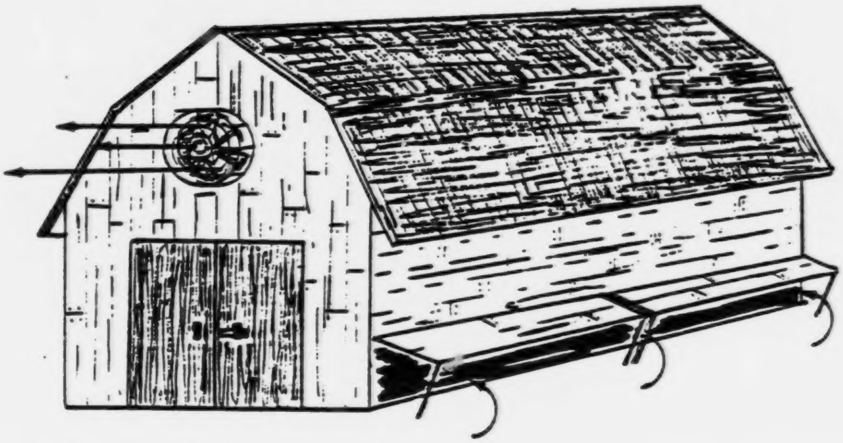
T8-6 *(Student Manual*, pages 202-207)

Creating a display is an important part of merchandising and advertising.

Underground Common Storage

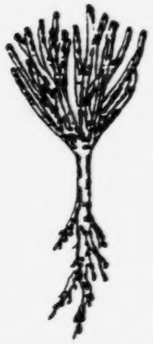

PACKING SHED
STORAGE RICKS

Frame Storage Building

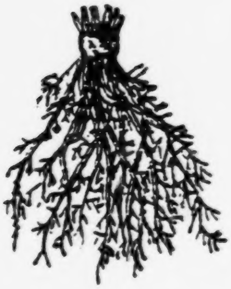


417

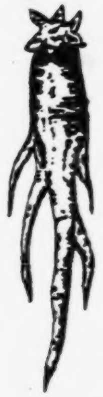
Root Systems of Perennials



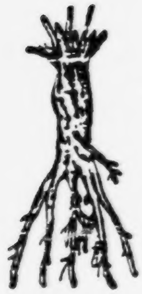
Carnation



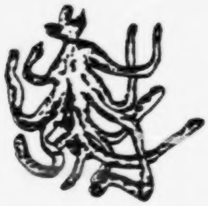
Pyrethrum



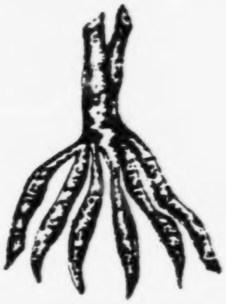
Hollyhock



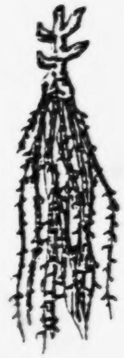
Delphinium



Artemisia

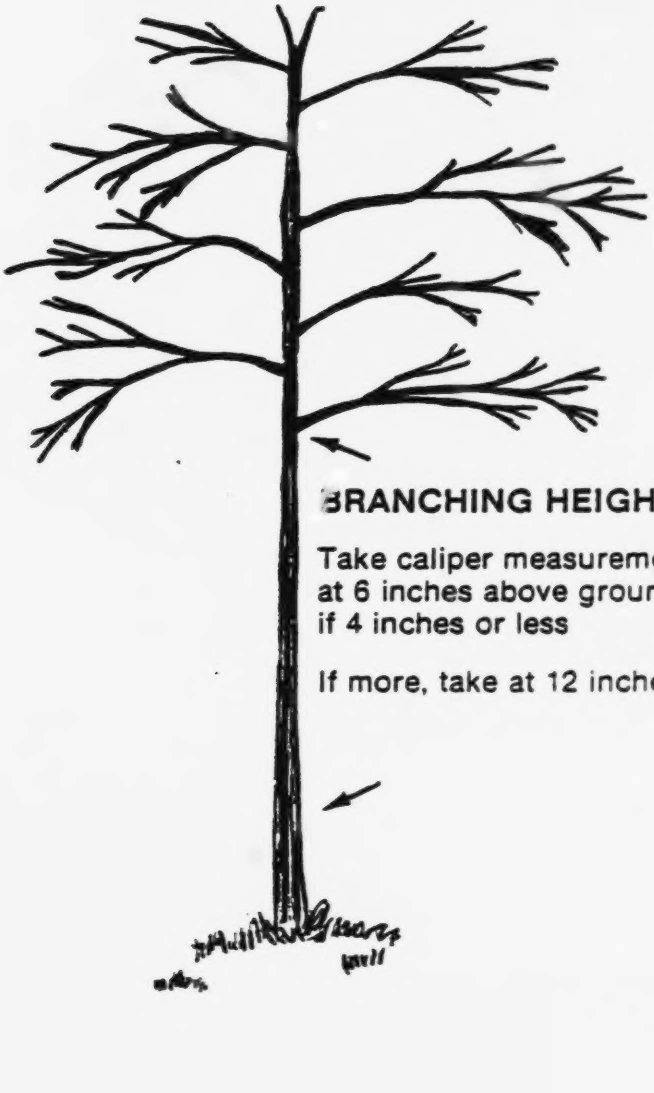


Day Lily



Phlox

Determining Caliper Size

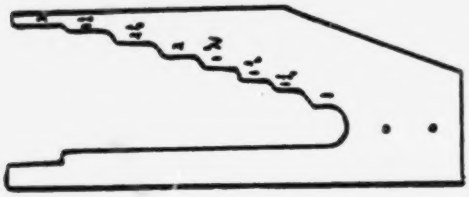


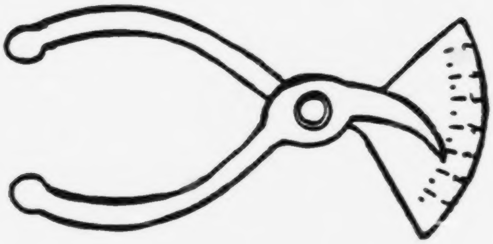
BRANCHING HEIGHT

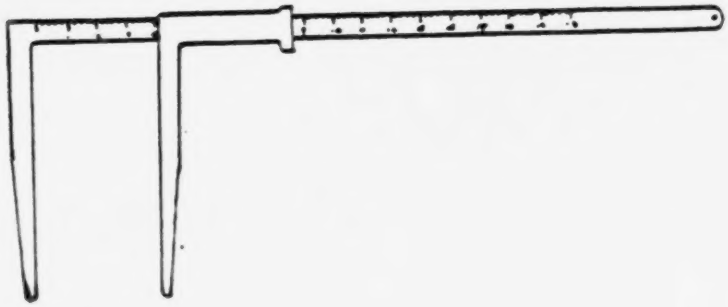
Take caliper measurement
at 6 inches above ground level
if 4 inches or less

If more, take at 12 inches

Types of Calipers







Creating a Display

1. Select seasonal items and plant material for the display.
2. Group seasonal items together.
3. Group large items together — mowers, tillers, etc.
4. Place colorful items, impulse items, etc. in high traffic area — near cash register or door.
5. Establish a good traffic pattern.
6. Display posters, advertising material, etc.
7. Restock display frequently.
8. Change display frequently.

CHAPTER 9

KEEPING RECORDS AND ACCOUNTS

PERFORMANCE CHECK LIST

1. List six typical nursery management decisions that can be made from an adequate set of records.
2. Name the major divisions of a chart of accounts according to a financial breakdown.
3. Name at least ten nursery activities for which a chart of accounts would be needed to make management decisions.
4. Explain how a shipping budget can be established from a record of orders booked.
5. Name the four accounting periods useful for nursery operators.
6. Explain how to determine average hourly labor costs from year to year to arrive at a decision for a price increase.
7. Name the two ways in which current prices of nursery stock have been derived.
8. Explain how to obtain a specific average price increase for a group of plants.
9. Explain how most nurseries obtain a yearly inventory count.

SUGGESTED LEARNING ACTIVITIES

1. Plan an interview with a nursery operator. Find out what types of management decisions are typically based upon records such as an inventory.
2. Introduce students to computer software and the forms used in a typical nursery operation.
3. Have a local labor leader visit the class and discuss work and wages.
4. Set up a nursery or garden center operation at the school. Use a record keeping system that students must maintain themselves.
5. Have students regularly inventory crops and supplies and keep inventory records up-to-date.

SAMPLE INTEREST APPROACH

Ask students, "What would happen if nursery operators did not keep good records?" Then ask how the nursery operator can determine how many plants are available for sale. Does someone have to go out into the field and count them? If the nursery operator does not keep records, how is the payroll calculated? Who would keep track of employee wages, fringe benefits, etc. if no records were kept by the manager? "How would you like to be paid for only half the time you actually worked because your employer kept terrible records and didn't know how much to pay you?" Continue with questions along this line until students see the value of record keeping. Then ask them to list the types of records needed in a typical nursery business. Move from there to a study of record keeping and accounts.

NAME ____________________

KEY QUESTIONS FOR CHAPTER 9

1. Why is record keeping important in a nursery business? (pages 209-210)

____

____

2. What types of records (answering what questions) does a nursery need? (page 210)

(1) ____________________
(2) ____________________
(3) ____________________
(4) ____________________
(5) ____________________
(6) ____________________
(7) ____________________
(8) ____________________

3. What is the biggest cost item in producing plants? (page 210)

____

4. Name three types of records dealing with labor which might be kept by a nursery operator. (pages 212-213)

____

____

5. List five types of records dealing with orders which might be kept by a nursery operator. (pages 213-214)

____

____

____

____

____

6. What are some of the major items included in a Statement of Profit and Loss? (page 215)

____

____

____

7. What is the "Sales Processing Labor Rate" and why is it important? (page 216)

____

____

____

(continued)

Key Questions *(continued)*

8. Explain the two ways in which nursery operators set the prices of their stock. (page 216)

9. When a price increase is necessary, what is the best time to put such an increase into effect? (page 217)

10. What is an inventory? (page 217)

11. Why are inventory records important? (page 217)

NAME ____________________

TERMS TO REMEMBER
Chapter 9

Match each term from the technical vocabulary list below with its correct definition. Fill in each blank with the appropriate word. If you need help, refer to Chapter 9 of *The Nursery Worker* or the Glossary at the end of this chapter.

Technical Vocabulary

account
assets
bookkeeping
budget
expenses
fixed cost

invoice
liability
merchandise
net worth
packing slip
revenue

____________________ 1. An official business relation, as with a store, allowing a customer or client certain credit privileges.

____________________ 2. A particular item or source of income.

____________________ 3. Money owed. Debts or obligations.

____________________ 4. A detailed list of goods sold or services provided, together with the charges and payment terms.

____________________ 5. The total resources of a person or business.

____________________ 6. An expense that cannot be modified.

____________________ 7. The sum of all a firm's assets minus liabilities.

____________________ 8. An estimate, often itemized, of expected income and expenses.

____________________ 9. The record system.

____________________ 10. Charges incurred during the transaction of business.

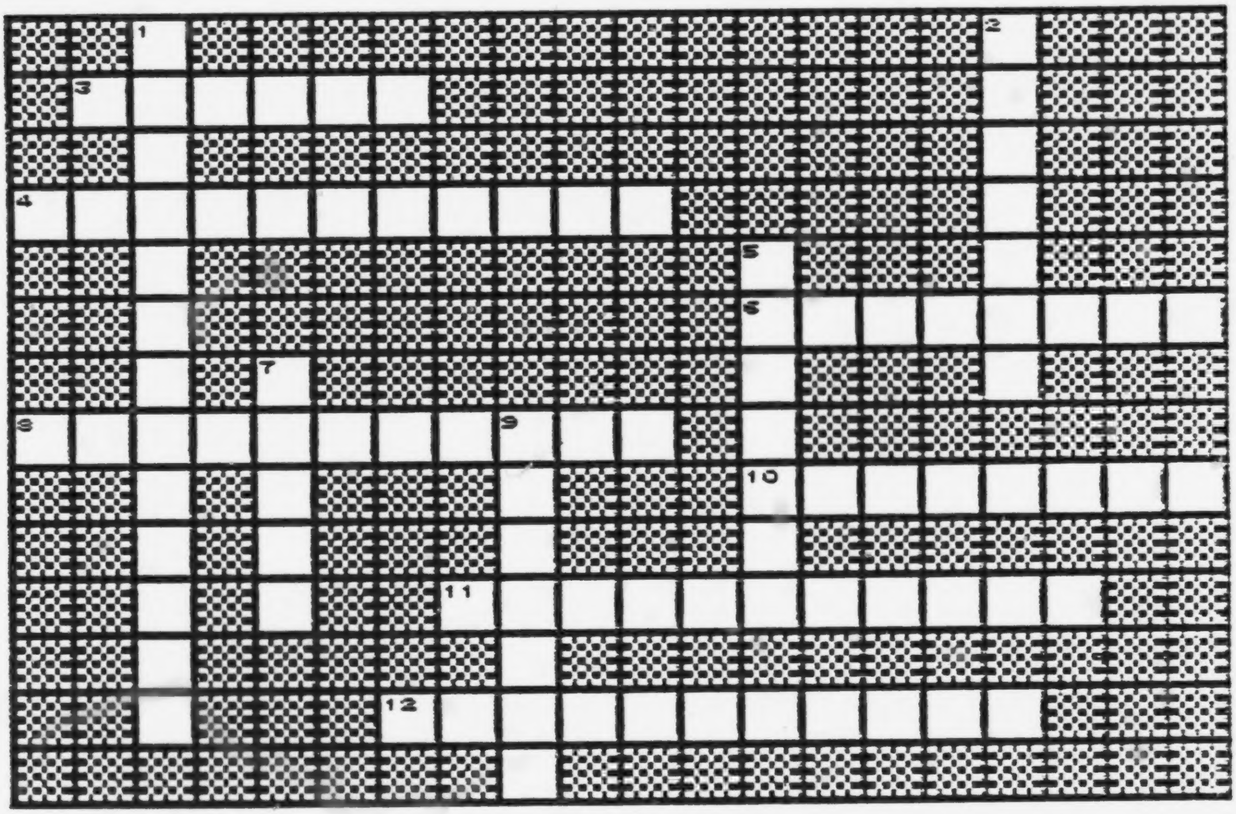
____________________ 11. A slip enclosed with each order shipped from the nursery. Lists package contents.

____________________ 12. Goods or commodities offered for sale.

NAME ____________________

CROSSWORD PUZZLE 9

Fill in the crossword puzzle with the missing words. If you need help, refer to Chapter 9 of *The Nursery Worker* or the Glossary at the end of this chapter.



ACROSS Clues

3. A financial statement of estimated income and expenses
4. Objects or materials offered for sale
6. The costs involved in operating a business
8. Debts which are owed
10. The total value of a business (2 words)
11. The practice of keeping records of all business transactions
12. A slip included with a shipment indicating which items have been sent (2 words)

DOWN Clues

1. The entire property of a business applicable to payment of its debts (2 words)
2. A record of debit and/or credit
5. Return from an investment, or a source of income
7. A cost which remains fairly constant (labor, heat, etc.): — a ________ cost
9. An itemized statement of merchandise shipped or sent to a purchaser

NAME ____________________

LETTER MAZE 9

The 10 words listed below are hidden in the letter maze. They may be written across, down, or diagonally. When you find a word, circle it.

```
G V X T G N L E D A P T Q N C B O O K K E E P I N G
T L F T J K J G D Q Y M M T R E U E Q C J V C N U M
O X F U F L H J Z Q M G Y V G S N F I R U K H V C X
L I A P G O F M F S E B W T R K Z O R T X U L J G E
I P B K S N P W J U I B N G M M V F V V D X C Y U Y
U M G X E M M J S I H U U T B N E F O E A J S L X K
F T L J H H T M C F O U Y H I R I C N H B E I F H A
G X R P I P U L F C P P Q Z Z S A K T T K G I G T F
H T A Q I M S Y C P Q C E R K B S R R W T U U E O L
E Z I I A Y V A M D U Q P V C T O D F Q Z R G G I K
I U S O Z T W W S J Y Q Z H W W M Q B O Y D V B A W
T I T E J T Y F V U F Y Y Z T D Z I H Y U I M M W U
O J A K V A R Q R P I E F E N U S X T B Q B H E B V
J X V I K X U S Q J W S N V D O W E V M G P A A U A
A A G V H S V W P G K X B K M S D D F D W D N V M R
L J C J P D D N X X V X I J D D T W E L T F M E D J
O W O F B F V E K M K D T P G J B L C W C J I K K I
W P N X G K U M J E G I G N V F N Z E W K B T X X C
H A N W N E F P X R W L W G P M I W T W S L G H Z K
R J H G Y K X P O Y T R E M P H J V M K H B Q B T S
A Z N W T C H G T D M E N H J C J W Z G Z O Q F T I
N T C I N B S I E H M Z I Q O F Z C Y Y H L O V R E
W B F L Q K L S D F V E V K A J O R Z B S A A A A E
I Y S P T I N K A H V S R T O H I G M V Z F H U Z W
U V B E B E G S R A R S N C A E F X L I T Q B S L M
C G S A P Q V E A S I Y Y D H Q S A N W O D H A U K
C S I X O L U L N M Q D Z N Z A S C M P Z B M L V L
A L E R Y N I Z B Q A T Y V M T N R O A E N D T Q L
X W U G E E I W M Q L B J J Y M M D G F J A V P B W
W E B V U N Y M F V J S O N V L S T I P W Y I O L H
H H E Z J N S M A P M M G P K K T Y R S H P C V T F
J R W T J M S M K F L B P E L O W V S I E J W X T U
```

ACCOUNT
ASSET
BOOKKEEPING
BUDGET
EXPENSE

INVOICE
LIABILITY
MERCHANDISE
NET WORTH
REVENUE

NAME ____________________

STUDENT EXERCISE 9-A

THE IMPORTANCE OF WEATHER CONDITIONS

The environment may have great impact on the operation and profit-making capacity of a nursery. Weather can affect plant growth directly. It can also influence the cultural practices used. Keeping records of weather conditions can help in predicting plant growth responses and overcoming potential difficulties.

MATERIALS:

Table 9-1, "Weather Conditions," and a sharp pencil

PROCEDURE:

1. Keep track of weather conditions for one week recording your findings daily in Table 9-1.
2. At the end of the week compute the average in each column.
3. Discuss your results in class.

EVALUATION:

Table was completed neatly and accurately. ____________

FINAL GRADE __________

(continued)

Student Exercise 9-A *(continued)*

Table 9-1. WEATHER CONDITIONS

Record for ______________________________ **Month** ____________________ **Year** __________

Day	Temperature		Wind	Rainfall	Sun	Remarks
	Max.	Min.				
1						
2						
3						
4						
5						
6						
7						
Total Avg.						

Adapted from: Recordkeeping and Data Acquisition, *Nursery Management Handbook*, Section 12, University of California, Agricultural Extension Service

NAME ____________________

STUDENT EXERCISE 9-B

PLANT INVENTORY RECORDS

Keeping a record of plants on hand makes it easier to handle orders quickly and efficiently. A good system will constantly keep track of additions and deletions. In this exercise you will practice taking an inventory and keeping it up-to-date.

MATERIALS:

Table 9-2 and a sharp pencil

PROCEDURE:

Using Table 9-2 keep track of all the additions and deletions from your plant inventory for at least one month.

EVALUATION:

Table 9-2 was completed accurately and neatly. ____________

FINAL GRADE ____________

Table 9-2. PLANT INVENTORY

Date	Identification Number or Species	Addition to Salable Inventory	Deletion from Salable Inventory	Total Salable

NAME ____________________

STUDENT EXERCISE 9-C

RECORD OF CHEMICALS USED

It is very important to keep accurate records of chemicals used on nursery crops: — which chemicals were applied, in what quantities, when, and by whom. For safety's sake, it is important to know this. But you must also have these data for each crop so that appropriate costs can be allocated for each crop.

MATERIALS:

Table 9-3 and a sharp pencil

PROCEDURE:

Using Table 9-3 keep track of all the chemicals you use in the nursery for at least one month.

EVALUATION:

Table 9-3 was completed neatly and accurately. ____________

FINAL GRADE ____________

Table 9-3. RECORD OF CHEMICALS USED

Date	Material	Amount	Enterprise/Crop

NAME ____________________

QUIZ - CHAPTER 9

TRUE OR FALSE

Read each statement completely. If the statement is false, circle "F." If the statement is true, circle "T".

T F 1. Record keeping is important in any business operation.

T F 2. An effective nursery record keeping system must be simple and inexpensive to install and operate.

T F 3. The first step in establishing an accounting system is to inventory all the plants in the nursery.

T F 4. The biggest cost item in producing plants is pesticides.

T F 5. An "Orders and Shipping Budget" can help nursery managers decide whether to hire more workers in order to get nursery stock to customers on time.

T F 6. A "Statement of Profit and Loss" is best analyzed at the end of the natural seasons.

T F 7. An "Hourly Labor Summary" can help managers determine the standard cost to the nursery for a particular operation.

T F 8. Inventory records kept from year to year can help managers measure how much labor costs are increasing from one year to the next.

T F 9. The "Sales Processing Labor Rate" is directly related to sales.

T F 10. Price increases should be made at the beginning of the summer season.

T F 11. A good nursery contains an inventory book which contains a record of how many plants of a particular variety and size are available for sale at any given time.

MULTIPLE CHOICE

Read each item and decide which choice answers the question or completes the statement. Circle the letter of the correct answer.

12. Which of the following is a typical "management decision"?

A. How many extra employees will be needed during the shipping season.
B. How many plants must be propagated to meet anticipated sales needs.

C. Whether the selling price of plants should be changed.

D. All of the above are management decisions.

13. Which of the following items would be listed on the "Chart of Accounts"?

A. current assets
B. fixed assets
C. a breakdown of nursery activities
D. expenses

14. The "Sales Processing Labor Rate" refers to . . .

A. the orders and shipping budget
B. digging and shipping labor costs
C. net worth
D. the hourly labor summary

15. All plants in the nursery should be counted . . .

A. once each week
B. once each month
C. four times a year
D. once a year

16. What is the biggest cost item of a nursery operation?

A. taxes
B. supplies
C. insurance
D. labor

ANSWER KEY - CHAPTER 9

Key Questions - page 9-2

1. Record keeping is important in a nursery business because records are needed for reporting tax information and for making management decisions.
2. A nursery needs records which tell managers —
   (1) how many plants must be propagated to meet anticipated sales needs.
   (2) how many extra employees will be needed during shipping season.
   (3) how many extra employees will be needed in the fall to dig anticipated shipments of various plants.
   (4) how much operating money must be borrowed from the bank for the current shipping season.
   (5) how much profit the company cleared during the last year.
   (6) how the selling price of plants will be changed to meet increasing costs of operation.
   (7) what is the average number of plants per day that can be dug by a particular digging crew.
   (8) how much of a bonus the various workers will receive this year.
3. The biggest cost item in producing plants is labor.
4. Three types of records dealing with labor which might be kept by a nursery operator include: a time card, a daily labor job record, and a weekly hourly labor summary.
5. Types of records dealing with orders which might be kept by a nursery operator include: an invoice, an order work copy, a packing slip, a receiving copy and an order acknowledgment, a record of orders booked, and an orders and shipping budget.
6. Some of the major items included in a Statement of Profit and Loss are: net sales, sales processing costs, production costs, gross profit, selling expenses, general and administrative expenses, net operating profit, other income, other expenses, and net profit.
7. The "Sales Processing Labor Rate" is the largest single cost item and is directly related to sales. The Sales Processing Labor Rate is important because it is the best indicator of the effect of price changes.
8. The two ways in which nursery operators set the prices of their stock are: (1) by an appraisal of supply and demand, and (2) by finding out what other nurseries in the area are charging.
9. The best time for a price increase is in spring.
10. An inventory is a count of all stock on hand.
11. Inventory records are important because they tell managers how many plants are available for sale. Inventory reports also help in planning for the future.

Terms to Remember - page 9-4

1. account
2. revenue
3. liability
4. invoice
5. assets
6. fixed cost
7. net worth
8. budget
9. bookkeeping
10. expenses
11. packing slip
12. merchandise

Crossword Puzzle 9 - page 9-5

ACROSS

3. budget
4. merchandise
6. expenses
8. liabilities
10. net worth
11. bookkeeping
12. packing slip

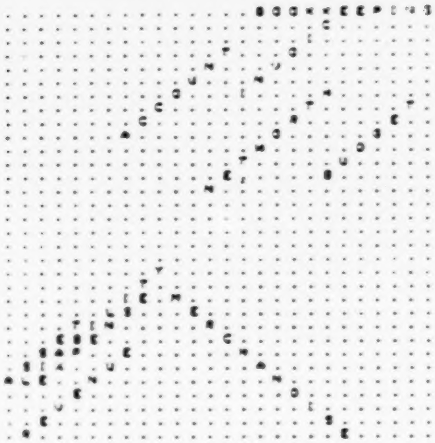
DOWN

1. current assets
2. account
5. revenue
7. fixed
9. invoice

(continued)

Answers *(continued)*

Letter Maze 9 - page 9-6



QUIZ

True or False - page 9-11	**Multiple Choice** - page 9-11
1. true	12. D
2. true	13. C
3. false	14. B
4. false	15. D
5. true	16. D
6. true	
7. true	
8. false	
9. true	
10. false	
11. true	

GLOSSARY - Chapter 9

account - an official business relation, as with a store, allowing a customer or client certain credit privileges.

assets - the total resources of a person or business.

bookkeeping - the work of keeping account books or the systematic records of money transactions.

budget - an estimate, often itemized, of expected income and expenses.

expenses - charges incurred during the transaction of business.

fixed cost - an expense that cannot be modified.

invoice - a detailed list of goods sold or services provided, together with charges and payment terms.

liability - money owed. Debts or obligations.

merchandise - goods or commodities offered for sale.

net worth - the sum of all a firm's assets minus liabilities.

packing slip - a slip listing package contents and enclosed with each order shipped from the nursery.

revenue - a particular item or source of income.

NARRATIVES FOR TRANSPARENCY MASTERS - Chapter 9

T9-1 *(Student Manual*, pages 209-210)

Production records can help nursery managers make better decisions.

T9-2

On this production record you would record weather conditions.

Question: How can a record of weather conditions help nursery operators?

T9-3

A record such as this can help improve production efficiency.

Question: What would records such as this be used for?

T9-4

Some nursery operators record soil mixtures and fertilizers used.

Question: Why is it important to know what kinds of soil mixtures or fertilizers were used?

T9-5

All nursery operators should have a record of which pesticides were used and when. Some may also keep track of how frequently plants were irrigated.

T9-6 and T9-7

Several types of costs are involved in producing any crop:— both production and marketing costs.

T9-8 *(Student Manual*, pages 210-211)

The **Chart of Accounts - Financial Breakdown** provides a breakdown of nursery activities. A breakdown of this type can provide information about a specific nursery activity.

T9-9 *(Student Manual*, pages 210-211)

The **Chart of Accounts - Organizational Breakdown** covers almost any activity that can be found in a nursery. The "Departments" section provides a further breakdown for information about a specific department and/or time of year.

Time cards are frequently used for hourly employees because labor is the biggest cost item in producing plants. Hours may be kept by hand or with a time clock.

Narratives for Transparency Masters *(continued)*

T9-10 *(Student Manual*, pages 210-212)

The **Daily Labor Job Record** is designed to be filled out by the crew supervisor for each crew member. This form is especially important because it is the basis for several other reports.

The **Weekly Hourly Labor Summary** uses information from the Daily Labor Job Records to determine the time spent in each nursery department for a given week.

T9-11 *(Student Manual*, pages 213-214)

Most orders received by wholesale nurseries arrive several months to several weeks before the shipping season. As orders are received (or booked) a record is kept to enable nursery operators to prepare a shipping budget.

T9-12 *(Student Manual*, pages 214-215)

The **Statement of Profit and Loss** is one of the most important reports a nursery operator prepares. Often accounts are analyzed at the end of the natural nursery seasons rather than weekly or monthly.

T9-13 *(Student Manual*, pages 214-215)

After the first 12 months' records have been compiled, the next year's reports should be a comparative statement. The **Hourly Labor Summary** enables managers to determine the standard cost to the nursery for a particular operation. With this information in hand, managers can begin to experiment with ways to lower costs.

Examples of Production Records

1. What plants were planted?
   When were they planted?
   How many were planted?
2. What soil moisture was used?
3. When were cultural practices carried out?
4. What types of fertilizer were applied?
   When?
5. How frequently were plants watered?
6. What chemicals were applied?
   How much was applied?
   When?
7. How many plants reached maturity?
   When?
   What was the quality or grade?
8. Were there any unusual environmental conditions which may have affected plant quality?

Adapted from Recordkeeping and Data Acquisition, *Nursery Management Handbook*— Section 12, University of California, Agricultural Extension Service

WEATHER CONDITIONS

Record for ____________________ **Month** ________________ **Year** ___________

Day	Temperature		Wind	Rainfall	Sun	Remarks
	Max.	Min.				
1						
2						
3						
4						
5						
6						
7						
Total Avg.						

Adapted from Recordkeeping and Data Acquisition. *Nursery Management Handbook* - Section 12. University of California. Agricultural Extension Service

EFFICIENCY AND SYSTEM OF PRODUCTION

Enterprise	Location		Plant Species and Variety	Product Designation		Date Planted	Number of Plants Started	Date to Active Inventory	Quality by Grade at Harvest		System of Production								Remarks
	Block	Bed		Size	Form					Culls	Soil Mix	Fertilization	Pest Control	Irrigation					

Adapted from Recordkeeping and Data Acquisition, *Nursery Management Handbook* - Section 12, University of California, Agricultural Extension Service

SOIL MIXTURES

Proportion	Ingredients	Fertilizer		Sterilization	Length of Stock Piling	Notes or Remarks
		Amount	Material			

FERTILIZATION SCHEDULE

Material	Rate of Application	Frequency of Application	Remarks

Adapted from Recordkeeping and Data Acquisition, *Nursery Management Handbook* - Section 12, University of California, Agricultural Extension Service

PEST CONTROL SCHEDULE

Description

IRRIGATION

Description

Adapted from Recordkeeping and Data Acquisition, *Nursery Management Handbook* - Section 12, University of California, Agricultural Extension Service

METHOD FOR ALLOCATING COSTS

Cost Classification	Individual Cost Items	Distribution Method to[5] —	
		Enterprise	Unit of Production
PRODUCTION			
1. Fixed Costs — Administration and Overhead	Management salaries[1]	B	B
	Office salaries[1] [2]	B	B
	Office utilities[1]	B	B
	Office supplies[1]	B	B
	Legal and accounting[1]	B	B
	Depreciation — general office[1]	B	B
	Depreciation — production facilities	A	B
	Interest on investment	B	B
	Taxes or rent or both[1]	A or B[3]	B
	Dues for organizations	B	B
	Subscriptions to journals	B	B
	Licenses	B	B
	Insurance on building, equipment[1]	A or B[3]	B
	Travel	B	B
	Research and development	B	B
	Donations	B	B
	Repair and maintenance	A or B[3]	B
	Freight and express in	A or B[3]	B
2. Variable - One Time	Labor for planting[2]	C	A
	Labor for mixing soil	C	A
	Soil mixture components	A	A
	Plants or seeds	A	A
	Containers	A	A
	Equipment for mixing soil	C	A
	Equipment for planting	C	A
3. Variable - Continuing	Labor for cultural practices[2]	C	B
	Fertilizer	B or C[4]	B
	Water	B or C[4]	B
	Chemicals	B or C[4]	B
	Hand tools	B	B
	Supplies — ties, stakes, lumber, etc.	A or C	B
	Fuel for heating greenhouse	A or B	B
	Equipment	C	B
4. Harvest Costs	Labor for harvest[2]	C	A
	Equipment	C	A
	Supplies	A	A

(continued)

442

METHOD FOR ALLOCATING COSTS — page 2

Cost Classification	Individual Cost Items	Distribution Method to[5] —	
		Enterprise	Unit of Production
MARKETING COSTS			
1. Fixed Costs — General Overhead and Administration	Management salaries	D	C
	Office salaries[1]	D	C
2. Variable Costs	Office supplies[1]	D	C
	Legal and accounting	D	C
	Depreciation[1]	D	C
	Insurance[1]	D	C
	Taxes or rent or both	D	C
	Salesman salaries and commissions	D	D
	Royalties	D	D
	Freight, express, postage out	D	D
	Advertising and promotion	D	C
	Travel[1]	D	C
	Utilities[1]	D	C
	Bad debts	D	C
	Discounts	D	D

[1] Proportional distribution on basis of space or time.

[2] To include all fringe benefits such as social security, profit sharing, etc.

[3] Basis of determining is whether building or land used for one enterprise or several.

[4] Usually determined by cultural practice followed.

[5] Method of cost distribution to enterprise.

A. Entire cost directly to enterprise because cost item not used for any other enterprise.
B. Proportionate amount based on area or square footage of production area occupied by the enterprise.
C. Time card basis of actual use.
D. Proportionate to number sold.

Distributing cost to unit of production

A. Directly by determining cost per unit (total cost divided by number of units), adjusting for losses.
B. On basis of area occupied for each unit of production.
C. Evenly distributed among all units sold.
D. Directly assigned only to plants sold.

Adapted from Recordkeeping and Data Acquisition, *Nursery Management Handbook* - Section 12, University of California, Agricultural Extension Service

CHART OF ACCOUNTS - FINANCIAL BREAKDOWN

CURRENT ASSETS

(code)
011 Petty Cash
012 Cash in Bank
013 Accounts Receivable

FIXED ASSETS

021 Land
022 Buildings
022-A Accumulated Depreciation—Buildings
023 Machinery and Equipment
023-A Accumulated Depreciation—Machinery and Equipment
024 Office Furniture and Fixtures
024-A Accumulated Depreciation—Office Furniture and Fixtures

CURRENT LIABILITIES

101 Accounts Payable
102 Accrued Wages
103 Accrued Taxes
104 Short Term Loans

FIXED LIABILITIES

121 Mortgage Payable

NET WORTH

130 Proprietorship

REVENUES

201 Sales
202 Sales Allowances
203 Purchases for Resale
204 Freight Out

EXPENSES

301 General Labor (See Form 1-A)
302 Social Security Taxes
303 Workmen's Compensation
304 Hospitalization Insurance
305 Employee Recreation and Education
306 Packaging Mixtures (peat moss, perlite, bark)
307 Packaging Supplies (burlap, pots, twine, nails)
308 Manure, Peat and Fertilizer
309 Weed Control Supplies
310 Insect Control Supplies

EXPENSES (cont.)

311 General Nursery Supplies
312 Repair and Maintenance—Buildings
313 Repair and Maintenance—Equipment
314 Gasoline and Lubricants
315 Electricity and Heating
316 Water and Irrigation Expense
317 Equipment Rental
318 Rent Expense
319 License and Fees
320 Soil and Water Conservation
321 Weather Protection
322 Depreciation of Buildings
323 Depreciation of Equipment
324 Real Estate Taxes
325 Other Taxes
326 Insurance Expense
327 Freight In
328 Purchase of Liners
329 Other Production Costs

340 Sales Salaries
341 Commissions
342 Telephone Expenses—Sales
343 Advertising and Promotion Expense
344 Traveling Expense
345 Customer Entertainment
346 Bad Debts
347 Other Selling Expenses

350 Management Salaries
351 Office Wages
352 Telephone Expense—General
353 Office Supplies
354 Legal and Accounting
355 Donations, Dues and Subscriptions
356 Other General Expenses

360 Purchase Discount
361 Miscellaneous Income

370 Interest Expense
371 Sales Discount
372 Miscellaneous Expenses

CHART OF ACCOUNTS - ORGANIZATIONAL BREAKDOWN

GENERAL LABOR

(code)	
01	Digging and Packaging
02	Hauling in From Field
04	Loading Customer Trucks
11	Planting
12	Cultivating
13	Hoeing and Weeding
14	Pruning
15	Insecticide Application
16	Irrigation
17	Chemical Weed Control Application
18	Fertilizer Application
19	Fitting Ground
20	Weather Protection
26	Repair and Maintenance—Equipment
27	Repair and Maintenance—Buildings
28	General Farm Maintenance
31	Greenhouse Labor
33	Field Propagation
50	Holiday, Sick Leaves and Vacations
60	Office Wages
61	Inventory

DEPARTMENTS

1	General Nursery
2	Spring Orders
3	Fall Orders
4	Storage
5	Landscape Department
6	Propagation
7	Others

TIME CARD

Week Ending ____________________, 19____

NO.

NAME

DEDUCTIONS		EARNINGS
SOC. SEC.	REG. HRS. AT	
INCOME TAX	O. T. HRS. AT	
HOSP.	TOTAL HRS.	
MISC.	TOTAL WAGES	
	TOTAL DEDUCTIONS	
TOTAL DEDUCTIONS	NET WAGES	

IN	OUT	IN	OUT	IN	OUT

DAILY LABOR JOB RECORD

Date________________________________

ORDERS	Dept.	EMPLOYEE CLOCK NUMBER 2	4	9	12	13	15	
01 Packaging and Digging	2	4	4	4	4	4	4	
02 Hauling In								
03 Yard								
04 Loading								
GROWING LABOR								
11 Planting	1	4	4	4	4	4	4	
12 Cultivating								
13 Hoeing and Weeding								
14 Pruning								
15 Insect Control								
16 Irrigation								
17 Weed Control								
18 Fertilizer								
19 Fitting Ground								
20 Weather Protection								
MAINTENANCE LABOR								
26 Rep. and Maint.—Equip.								
27 Rep. and Maint.—Bldgs.								
28 General Farm Maint.								
PROPAGATION LABOR								
31 Greenhouse Labor								
32 Taking Cuttings								
33 Field Propagation								
OTHER LABOR								
50 Holi., Sick Lve. and Vaca.								
60 Office								
61 Inventory								
TOTAL HOURS		8	8	8	8	8	8	

DEPARTMENTS

1 General Nursery	5 Landscape Dept.
2 Spring Orders	6 Propagation
3 Fall Orders	7 Others
4 Storage	

____
Foreman

____
Supervisor

WEEKLY HOURLY LABOR SUMMARY

Week Ending__________________________ 19_____

DEPARTMENT	1 General Nursery	2 Spring Orders	3 Fall Orders	4 Storage	5 Landscape Dept.	6 Propagation	7 Others
ORDERS							
01 Packaging							
02 Hauling In							
03 Yard							
04 Loading							
GROWING LABOR							
11 Planting							
12 Cultivating							
13 Hoeing and Weeding							
14 Pruning							
15 Insect Control							
16 Irrigation							
17 Weed Control							
18 Fertilizer							
19 Fitting Ground							
20 Weather Protection							
MAINTENANCE LABOR							
26 Rep. & Main.—Equip.							
27 Rep. & Main.—Bldgs.							
28 General Farm Main.							
PROPAGATION LABOR							
31 Greenhouse Labor							
32 Taking Cuttings							
33 Field Propagation							
OTHER LABOR							
50 Holi., Sick Lve., Vaca.							
60 Office							
61 Inventory							
TOTALS							

RECORD OF ORDERS BOOKED

Date	Order No.	Customer Name	Location	Order Amount	Date Shipped	Shipped Amount
2-1	Orders Booked to Date			25,000.00		
2-3	2304	A.B.C. Landscape	Akron, O.	1,000.00		
2-4	2305	Modern Landscaping	Columbus, O.	500.00		
2-4	2306	John's Garden Center	Cleveland, O.	600.00		
2-6	2307	City of Toledo	Toledo, O.	900.00		
2-9	Orders Booked This Week			3,000.00		
2-9	Orders Booked to Date			28,000.00		
2-10	2308					

ORDERS AND SHIPPING BUDGET

	ORDERS BOOKED			ORDERS SHIPPED		
Period Ending	Last Year Actual	This Year Budget	This Year Actual	Last Year Actual	This Year Budget	This Year Actual
Oct. 1	2,000	3,000	1,600			
15	4,000	5,000	5,000			
Nov. 1	7,000	8,000	7,000			
15	10,000	11,000	12,000			
Dec. 1	12,000	14,000	14,000			
15	14,000	16,000	16,000			
Jan. 1	15,000	17,000	18,000			
15	18,000	20,600	21,000			
Feb. 1	22,000	25,000	25,000			
9	24,000	27,000	28,000			
16	27,000	30,000	32,000			
23	31,000	35,000	36,000			
Mar. 2	34,000	38,000	37,000			
9	37,000	41,000	40,000			
16	40,000	44,000	43,000	2,000	3,000	1,000
23	42,000	47,000	45,000	7,000	8,000	6,000
30	45,000	49,000	47,000	13,000	15,000	14,000
Apr. 6	47,000	52,000	52,000	20,000	22,000	—
13	50,000	54,000	—	26,000	29,000	—
20	52,000	56,000	—	32,000	36,000	—
27	54,000	58,000	—	39,000	43,000	—
May 4	56,000	60,000	—	45,000	50,000	—
11	57,000	62,000	—	50,000	55,000	—
18	59,000	64,000	—	55,000	60,000	—
25	60,000	66,000	—	58,000	63,000	—
31	60,000	66,000	—	60,000	66,000	—

STATEMENT OF PROFIT AND LOSS

		Dollar Volume	Percent
201	Sales	$110.000	
202	LESS: Sales Allowances	2.000	
203	Purchases for Resale	5.000	
204	Freight Out	3.000	
	NET SALES FROM NURSERY	$100.000	100.0%
	Packaging and Shipping Costs		
301	Sales Processing Labor (Form 8-A)	$ 17.000	17.0%
306	Packaging Mixtures	1.000	1.0
307	Packaging Supplies	7,000	7.0
	TOTAL SALES PROCESSING COSTS	$ 25.000	25.0%
	Production Costs		
301	Propagation Labor (Form 8-A)	$ 2.000	2.0%
301	Growing Labor (Form 8-A)	7.000	7.0
301	Maintenance Labor (Form 8-A)	3.000	3.0
301	Other Hourly Labor (Form 8-A)	2.000	2.0
302	Social Security Taxes	1.500	1.5
303	Workmen's Compensation	500	.5
304	Hospitalization Insurance	500	.5
305	Employee Recreation and Education	300	.3
308	Manure, Peat and Fertilizer	2.000	2.0
309	Weed Control Supplies	1.500	1.5
310	Insect Control Supplies	1.500	1.5
311	General Nursery Supplies	1.000	1.0
312	Repair and Maintenance—Buildings	1.000	1.0
313	Repair and Maintenance—Equipment	2.000	2.0
314	Gasoline and Lubricants	1.500	1.5
315	Electricity and Heating	800	.8
316	Water and Irrigation Expense	700	.7
317	Equipment Rental	1.000	1.0
318	Rent Expense	1.000	1.0
319	License and Fees	300	.3
320	Soil and Water Conservation	1.000	1.0
321	Weather Protection	1.000	1.0
322	Depreciation of Buildings	1.500	1.5
323	Depreciation of Equipment	1.500	1.5
324	Real Estate Taxes	1.000	1.0
325	Other Taxes	500	.5
326	Insurance Expense	500	.5
327	Freight In	500	.5
328	Purchases and Liners	2.000	2.0
329	Other Production Costs	1.400	1.4
	TOTAL PRODUCTION COSTS	$ 42.000	42.0%
	GROSS PROFIT FOR OPERATIONS	$ 33.000	33.0%

		Dollar Volume	Percent
	Selling Expenses		
340	Sales Salaries	$ 2.000	2.0%
341	Commissions	2.000	2.0
342	Telephone Expense—Sales	500	.5
343	Advertising and Promotion Expense	2.000	2.0
344	Traveling Expense	800	.8
345	Customer Entertainment	400	.4
346	Bad Debts	100	.1
347	Other Selling Expenses	200	.2
	TOTAL SELLING EXPENSES	$ 8.000	8.0%
	General and Administrative Expenses		
350	Management Salaries	$ 13.000	13.0%
351	Office Wages	2.000	2.0
352	Telephone Expense—General	500	.5
353	Office Supplies	500	.5
354	Legal and Accounting	500	.5
355	Donations, Dues and Subscriptions	200	.2
356	Other General Expenses	300	.3
	TOTAL GENERAL AND ADMINISTRATIVE EXPENSES	$ 17.000	17.0%
	NET OPERATING PROFIT	$ 8.000	8.0%
	Other Income		
360	Purchase Discount	$ 500	.5%
361	Miscellaneous Income	500	.5
	TOTAL OTHER INCOME	$ 1.000	1.0%
	Other Expenses		
370	Interest Expense	$ 1.000	1.0%
371	Sales Discount	500	.5
372	Miscellaneous Expenses	500	.5
	TOTAL OTHER EXPENSES	$ 2.000	2.0%
	NET PROFIT	$ 7.000	7.0%

COMPARATIVE STATEMENT OF PROFIT AND LOSS

	This Year		Last Year	
	Amount	Percent	Amount	Percent
Gross Sales	$110,000		$102,000	
Less: Sales Allowance	2,000	2.0%	1,500	1.6%
Purchases for Resale	5,000		4,500	
Freight Out	3,000		4,000	
Net Sales From Nursery	$100,000	100.0%	$ 92,000	100.0%
Packaging and Shipping Cost				
Sales Processing Labor (See Form 8-A)	$ 17,000	17.0%	$ 15,000	16.3%
Packaging Mixtures	1,000	1.0%	900	1.0%

HOURLY LABOR SUMMARY

	Dollar Volume	Percent
Sales Processing Labor:		
01 Digging and Packaging	$ 12,000	12.0%
02 Hauling in From Field	2,000	2.0
04 Loading Customer Trucks	3,000	3.0
TOTAL SALES PROCESSING LABOR	$ 17,000	17.0%
Growing Labor:		
11 Planting	$ 2,000	2.0%
12 Cultivating	600	.6
13 Hoeing and Weeding	2,000	2.0
14 Pruning	600	.6
15 Insecticide Application	400	.4
16 Irrigation	300	.3
17 Chemical Weed Control Application	300	.3
18 Fertilizer Application	200	.2
19 Fitting Ground	100	.1
20 Weather Protection	500	.5
TOTAL GROWING LABOR	$ 7,000	7.0%
Maintenance Labor:		
26 Repair and Maintenance—Equipment	$ 1,000	1.0%
27 Repair and Maintenance—Buildings	1,000	1.0
28 General Farm Maintenance	1,000	1.0
TOTAL MAINTENANCE LABOR	$ 3,000	3.0%
Propagation Labor:		
31 Greenhouse Labor	$ 1,000	1.0%
33 Field Propagation	1,000	1.0
TOTAL PROPAGATION LABOR	$ 2,000	2.0%
Other Hourly Labor:		
50 Holiday, Sick Leaves and Vacations	$ 1,500	1.5%
61 Inventory	500	.5
TOTAL OTHER HOURLY LABOR	$ 2,000	2.0%
TOTAL HOURLY LABOR	$ 31,000	31.0%

GLOSSARY

account - an official business relation, as with a store, allowing a customer or client certain credit privileges.

adjuvant - compatibility agents used to prevent two pesticides or a pesticide-fertilizer mixture from separating when combined in a sprayer.

adventitious root - a root produced in an unusual place or part of a plant — typically roots produced on above-ground plant parts.

advertising - to describe or present a product or service in order to induce consumers to buy it.

agar - a gelatin-like product used for solidifying certain culture media in micropropagation.

aggregate - a group of soil particles.

agronomy - the science of soil management and the production of field crops.

air layering - causing certain plants to produce roots above ground by use of special propagation techniques.

annual - a plant that completes its life cycle in one year.

anther - the male, pollen-producing part of a flower.

apical dominance - the apical (tip) bud causes a chemical hormone (auxin) to be produced in the plant. This hormone prevents the growth of buds below the apical bud. When the apical bud is removed the hormone is no longer present, and the side buds will grow.

arborist - a specialist in the care and maintenance of trees.

asexual reproduction - plant reproduction without the use of seeds.

assets - the total resources of a person or business.

auxin - a chemical growth hormone found in plants.

axillary bud - a bud found in the axil of a leaf.

bacteria - certain microscopic organisms that can cause disease in plants or animals.

bark - the exterior tissue or covering of a woody trunk or stem from the cambium outward. Consists mainly of dead tissue.

biennial - a plant which produces leaves the first year of its life. It produces flowers, fruit, and seeds the second year and then dies.

bookkeeping - the work of keeping account books or the systematic records of money transactions.

broadleaf evergreen - plant with relatively broad leaves (as opposed to needles) that remain green throughout the year.

budding - the insertion of a bud from one plant beneath the bark of another plant so that the cambium layers join and grow together to form a new plant.

budget - an estimate, often itemized, of expected income and expenses.

budstick - a stem or branch from which buds are removed in budding.

budwood - also known as budstick. The current season's growth from which single buds are removed.

bulk density - the weight of soil.

Glossary *(continued)*

calibrate - to determine, check, or change the graduation of any instrument giving quantitative measurements.

caliper - in landscape and nursery usage, the diameter of a tree measured 6 inches above the ground line if up to a 4-inch caliper, or 12 inches above the ground line if of a larger caliper.

calyx - the external, leafy part of a flower made up of sepals. Usually green, but may possess other color in some flowers.

cambium - a layer of delicate meristematic tissue between the inner bark (phloem) and the wood (xylem) that produces all secondary growth in plants. Responsible for the annual rings in wood.

capillary action - the upward movement of water in soil resulting from the attraction of water molecules to each other and to the soil particles.

capillary water - water that is available to plants; water that is held more tightly to the soil particle than the pull of gravity, but weakly enough to allow it to be used by plants.

carbohydrates - organic compounds that form the supporting tissues of plants and are important food for animals and people.

chlorophyll - green plant pigment that absorbs the energy of sunlight for use in manufacturing sugars from carbon dioxide and water.

chlorosis - lack of chlorophyll development because of nutritional problems, such as lack of iron or magnesium. Can also be caused by disease.

compatibility agent - adjuvant used to prevent two pesticides or a pesticide-fertilizer mixture from separating when combined in a sprayer.

complete fertilizer - a fertilizer containing nitrogen, phosphorus, and potassium.

concentrate - a condensed formulation usually diluted with water or oil before use.

conifer - cone-bearing plant with needlelike leaves.

contact herbicide - a weed killer that acts primarily by touching plant tissue rather than as a result of translocation. Usually affects only that portion of the plant with which it comes in direct contact.

container stock - plants grown in some type of container.

corolla - the petals of a flower.

cotyledon - the first leaf or leaves in a seed.

cover crop - a herbaceous crop sown to cover the ground temporarily. Protects the ground from erosion. Generally, the crop is plowed under for its organic value.

cross-pollination - the contact of pollen from one plant with the stigma of a different plant.

cultures - in micropropagation, the actively dividing tissues.

cuticle - the thickened, waxy surface layer of certain leaves, fruits, and shoots.

defoliation - the process of losing leaves.

dibble - a pointed implement of wood, metal, or plastic used to make holes in the soil when planting or transplanting.

dicot (or **dicotyledon**) - a plant producing seeds which have two cotyledons or seed leaves.

differentially permeable membrane - membrane which, to different degrees, allows the passing of solution through it.

dolomite - a mineral (calcium magnesium carbonate) used to raise the pH of soil.

Glossary *(continued)*

dormant (noun-**dormancy**)- not in active growing condition. Capable of resuming growth when environmental conditions are favorable.

drilling - seeding in rows.

embryo - part of a seed that grows and develops into a plant upon germination.

emulsifiable concentrate - a concentrated liquid pesticide which mixes readily with water.

endodermis - a specialized tissue in the roots and stems of certain plants.

endosperm - part of the seeds of certain plants, located beside the embryo. Consists of food materials.

entomology - the study of insects.

erosion - the process of wearing away of rocks and soil by natural agents.

espalier - a method of training plants to grow decoratively along a railing or trellis.

expenses - charges incurred during the transaction of business.

explant - living material taken from an animal or plant and placed in a culture medium.

field capacity - the amount of water soil can hold after draining off excess gravitational water.

field stock - plants grown in the field as opposed to containers.

filament - the anther-bearing stalk of a stamen.

fixed cost - an expense that cannot be modified.

footcandle - a unit of light equivalent to the light produced by one candle at a distance of one foot.

fumigant - chemical used to kill insects, nematodes, fungi, bacteria, seeds, roots, rhizomes, or entire plants. Typically used within the soil.

fungi - parasitic or saprophytic plant organisms responsible for certain plant diseases.

gall - abnormal growth of plant tissue around the eggs or larvae of an insect parasite.

garden center - a retail business generally selling plants and related supplies.

germicide - an agent for killing germs or microorganisms.

girdle - to remove a strip of bark from around a tree trunk or branch. This practice is sometimes used to grow larger fruits, to induce rooting, or to kill a tree.

grading - arranging or sorting plants according to quality or size.

grafting - implanting a scion from one plant into a growing plant called the stock. The cambium layers contact each other enabling the scion to derive water and nutrients from the stock. This eventually results in a union of the two parts.

gravitational water - water that is free to move through soil under the influence of gravity.

green manure crop - a cover crop which is plowed under while still green to improve the soil.

grub - the larval stage of some insects.

guard cells - two cells that flank the leaf stomate (pore) and cause it to open and close.

hardening off - the process of acclimating plants to outdoor conditions.

hardwood cutting - a stem cutting made from the mature wood of either a deciduous plant or a narrow-leaved evergreen.

Glossary *(continued)*

herbaceous cutting - a cutting taken from leafy, succulent plants such as geraniums.

herbaceous perennial - a perennial plant that does not develop a woody stem.

horizon - a layer of soil which differs in composition and/or structure from adjacent layers.

hourly worker - a worker paid by the hour.

hygroscopic water - water or moisture strongly attached to soil particles.

hypocotyl - in the embryo of a plant, the part of the stem below the cotyledons.

igneous rock - rock produced under intense heat, such as rocks of volcanic origin.

imbibition - the absorption of liquid or moisture.

imperfect flower - a flower containing only the staminate (male) or pistillate (female) flower parts, but never both.

incomplete fertilizer - a fertilizer such as 28-0-0 or 0-10-30 which contains only one or two of the three major plant nutrients.

infiltration - filtering into or permeating the soil.

inventory - a detailed list of articles usually including code number, quantity, and value of each item.

in vitro culture - growing plants on artificial media in test tubes or flasks.

invoice - a detailed list of goods sold or services provided, together with the charges and payment terms.

iron chlorosis - yellowing symptoms resulting from a plant's reaction to an alkaline soil which causes iron to become insoluble and unavailable.

Jiffy-7 - compressed peat pellet which combines the functions of a pot and potting soil in one unit.

landscape maintenance - caring for established plantings.

landscaping - improving the environment with the design and construction of plantings.

larva - the immature, wingless feeding stage of an insect that undergoes complete metamorphosis.

layering - a propagation method in which a part of a stem, shoot, or branch is covered with soil or some other rooting medium. After rooting has taken place, the new plant is separated from the parent plant.

leaching - washing out of soluble materials from the soil.

leader - the terminal or primary shoot of a plant.

liability - money owed; debts or obligations.

limbed-up - the process by which lateral tree branches that have sprouted near the ground are removed.

liners - young plants grown in rows in the field.

loam - a soil containing relatively equal parts of sand, silt and clay.

macronutrient - a chemical element which is required in considerable abundance for the growth and survival of plants.

marketing - all activities by which transfer of title or possession of goods from seller to buyer is effected. Includes advertising, shipping, storing, and selling.

mechanization - the process of replacing human labor with mechanical equipment.

merchandise - goods or commodities offered for sale.

Glossary *(continued)*

merchandising - all planning, advertising, and other activities involved in promoting sale of a product.

meristematic zone - area of embryonic tissue made up of undifferentiated, growing, actively dividing cells.

mesocotyl - specialized cells located between the scutellum and coleoptile.

metamorphic rock - rock formed through a process of change caused by pressure or heat.

metamorphosis - the structural or functional modification of a living organism during its development.

micronutrient - a chemical element essential to the growth of plants but required only in very small amounts.

microorganism - a microscopic plant or animal.

micropropagation - tissue culture so called because only small pieces of the stock plant are used.

monocot (or **monocotyledon**) - a plant producing seeds which contain a single cotyledon or seed leaf.

mottled - spotted or blotched in coloring.

mulch - a loose dry material used as a protective covering over the soil.

mycelium - the fine, threadlike growth of a fungus.

mycoplasma - a "fungus form" organism responsible for certain plant diseases such as aster yellows.

narrowleaf evergreen - a plant with needlelike leaves that remain green throughout the year.

necrosis - the death of plant cells in a living plant. Symptoms include spots, rings, or strands of discoloration in foliage, fruits, tubers, and other tissue.

nematode - a tiny worm-like organism which is sometimes parasitic on plants.

net worth- the sum of all the assets of a firm minus its liabilities.

node - a joint on a stem where a bud, leaf, or flower stalk is attached.

nonselective herbicide - a pesticide which destroys or prevents the growth of plants in general without regard to species.

nursery - a business which grows woody and/or herbaceous plants.

nutrient - a substance which a plant synthesizes into food.

nymph - the young of an insect that undergoes incomplete metamorphosis.

ovary - in a flower, the basal part of the pistil which develops into the fruit.

packing slip - a slip listing package contents and enclosed with each order shipped from the nursery.

palisade mesophyll - the layer of cells just beneath the upper surface of the leaf.

pallet - a platform (usually wooden) for holding material for storage or transportation, as in a warehouse.

parasite - a pest or organism that lives upon another organism.

parent material - also known as the C horizon - the layer below the solum.

pasteurize - expose to a high temperature in order to destroy certain microorganisms.

pedicel - stem or stalk of a flower.

perennial - a plant that continues to live from year to year. In cold climates the tops may die, but the roots and rhizomes persist.

Glossary *(continued)*

perfect flower - a flower containing both staminate (male) and pistillate (female) parts.

perlite - a lightweight, granular material made out of a volcanic mineral. It is treated by heat and water so that it expands like popcorn. Used as or in a growing medium.

pH - a symbol used to express the degree of both acidity and alkalinity.

phloem - meristem cells which conduct food downward; located in the bark of woody plants next to the cambium.

photoperiod - the time during which a plant is exposed to daylight.

photosynthesis - the manufacture of carbohydrates (food) from carbon dioxide and water in the presence of chlorophyll. Uses light energy and releases oxygen.

piece-rate worker - worker (usually temporary) paid by the amount of work done rather than by the hour.

pistil - the female part of a flower comprised of ovary, stigma, and style.

pith - the spongy tissue within a stem.

placenta - the part of the ovary of flowering plants which bears the ovules.

plant analysis - testing plant material to determine the presence and amounts of nutrients actually in the plant.

plant pathology - the study of plant diseases.

plumule - the primary bud of an embryo or germinating seed plant.

preplant herbicide - herbicide applied to eliminate problem weeds before planting the crop.

pupa - an insect in a non-feeding, usually immobile, transformation stage.

quarantine - isolation to prevent the spread of infection to organisms or geographic regions.

radicle - the lower part of an embryo seedling.

record system - bookkeeping system.

respiration - the process of carbohydrate utilization by a living organism. Releases energy and liberates water and carbon dioxide.

retail - selling merchandise to consumers as opposed to other businesses.

revenue - a particular item or source of income.

rhizome - underground rootlike stem which sends out leafy shoots from its upper surface and roots from its lower side.

rick - large stack or pile of something, such as hay or straw.

rodenticide - substance or preparation for killing rodents.

root hair - hair-like, tubular outgrowth near the tip of a rootlet, performing the work of absorption.

rootstock - a root and its associated growth buds. Used as a stock plant in propagation.

salaried worker - a worker paid a flat rate regardless of the number of hours worked or the amount of work done.

saturation point - the point at which a soil cannot hold any more moisture.

scarification - a method of scratching hard-coated seeds to weaken seed coats and thus hasten germination.

Glossary *(continued)*

scion - a detached shoot or other portion of a plant consisting of one or more buds. Used in propagation by grafting.

scutellum - a small plate or shieldlike part of a root.

sedimentary rock - rock formed by the deposit of sediments.

selective herbicide - a herbicide which kills certain plants with little or no damage to others.

self-pollination - pollination by the anthers of the same flower.

semi-hardwood cutting - shoot of plant that has recently experienced active growth period. The wood is partially matured.

sepal - one part (usually green) of the calyx of a flower.

sexual reproduction - reproduction of plants by seeds as opposed to asexual reproduction by cuttings, grafting, etc.

softwood cutting - cutting taken from a woody plant before new growth has hardened or matured.

soil - a natural layer of mineral and organic materials on the earth's surface in which plants grow.

soil-building crop - a crop which helps maintain tilth and prevent loss of soil.

soil profile - diagram of the vertical section of a soil showing the thickness and character of the various soil horizons.

soil structure - the arrangement of mineral particles in the soil.

soil texture - the size of soil particles and the proportion of sand, silt, and clay.

solum - the combination of A and B horizons where most plant root growth takes place.

somatic hybridization - fusion of plant cells from incompatible species.

stamen - the reproductive organ of the male pollen-bearing flower.

sterilization - the process of making a soil free of all harmful organisms by the use of heat, steam, or fumigation.

stigma - the part of the pistil in a flower which receives the pollen grains.

stolon - a stem growing horizontally on or just below the surface of the ground and usually rooting at nodes and producing a new plant at the top.

stomate - pore or minute hole in the surface of a plant leaf or stem through which gas or water vapor passes.

stratification - (1) storage of seeds between layers of earth, leaves, or other material; (2) burying seeds to keep them fresh and moist, but not so warm as to germinate; (3) treatment used to break the dormancy of cold-requiring seeds.

style - a prolongation of the ovary that supports the stigma.

subsoil - section of the soil below the usual depth of cultivation, which contains little or no humus; generally more dense than topsoil.

surfactant - any substance which, when dissolved in water, reduces surface tension between it and another liquid.

systemic poison - a pesticide which is absorbed directly into the plant and translocated to plant parts above the ground.

tile drainage - internal drainage of a soil by way of buried concrete, clay, or plastic tiles.

Glossary *(continued)*

tissue culture - a method of plant propagation in which small sections of plant tissue are separated from the mother plant and grown independently.

topography - the lay of the land.

topsoil - (1) a fertile soil or soil material rich in organic matter; (2) surface soil; (3) the original, dark-colored, upper soil ranging from a fraction of an inch to many feet in depth.

translocated herbicide - herbicide which moves within the plant and kills all parts of it.

transpiration - the emission of water vapor from the aerial parts of a plant chiefly through leaf stomates.

transplant - the process of shifting a plant from one container or location to another.

turgid - having adequate moisture in plant cells.

understock - the rooted part of a plant to which the scion is grafted.

vascular bundle - in stems, a group of strands of specialized conductive and mechanical tissue.

vascular tissue - tissue in which tube- or ductlike cells translocate food and water within the plant.

vermiculite - a lightweight expanded mica product often used as a rooting medium for plants or as a soil amendment.

viable - capable of germination or growth.

virus - minute organism frequently causing disease.

weed - an unwanted plant, especially one that aggressively competes with desired plant varieties.

wholesale - selling merchandise to other businesses rather than to consumers.

wood - structural cells in the stems of trees and shrubs.

xylem - water-conducting, woody tissue in higher plants.